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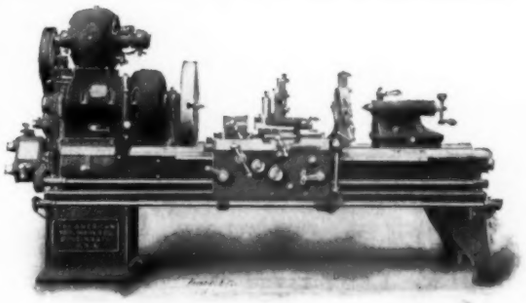

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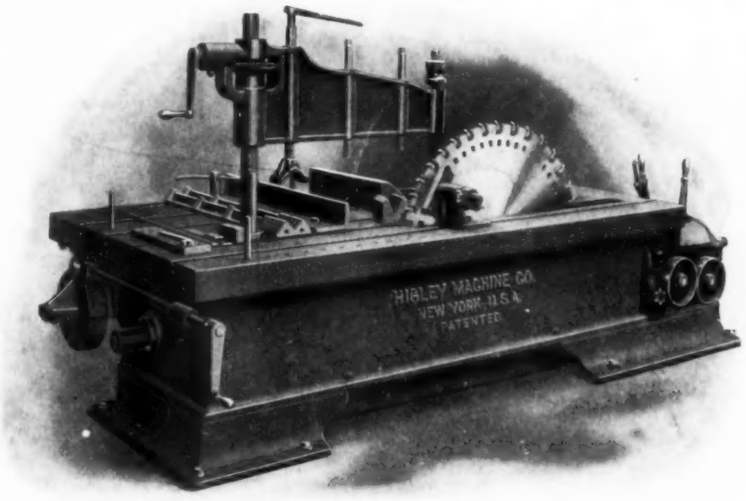

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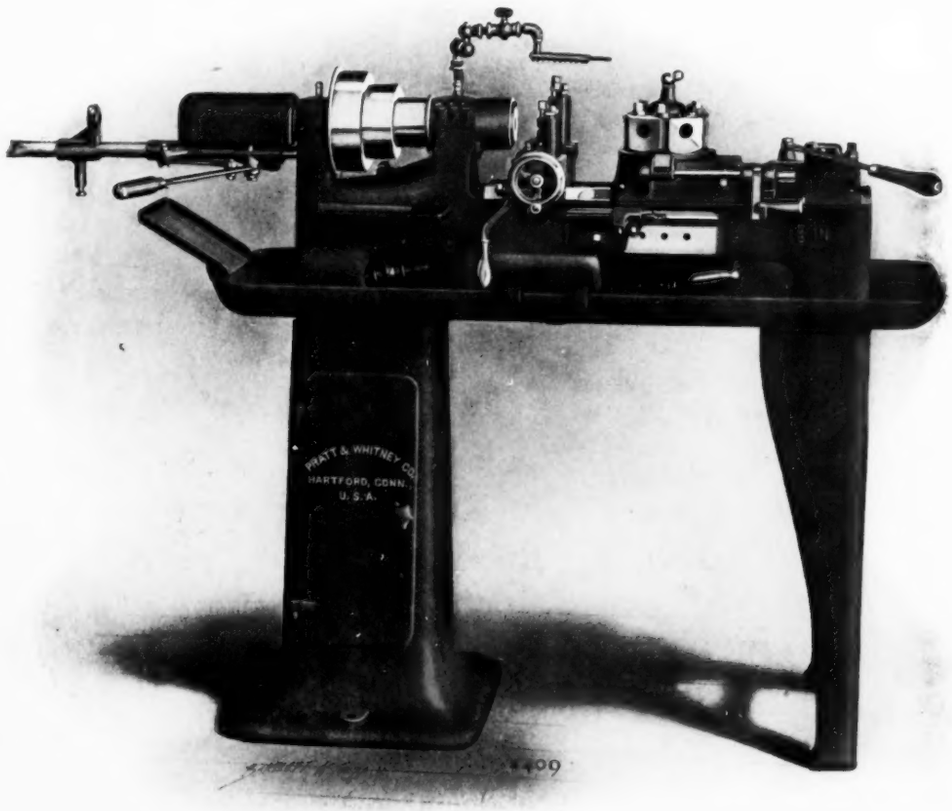

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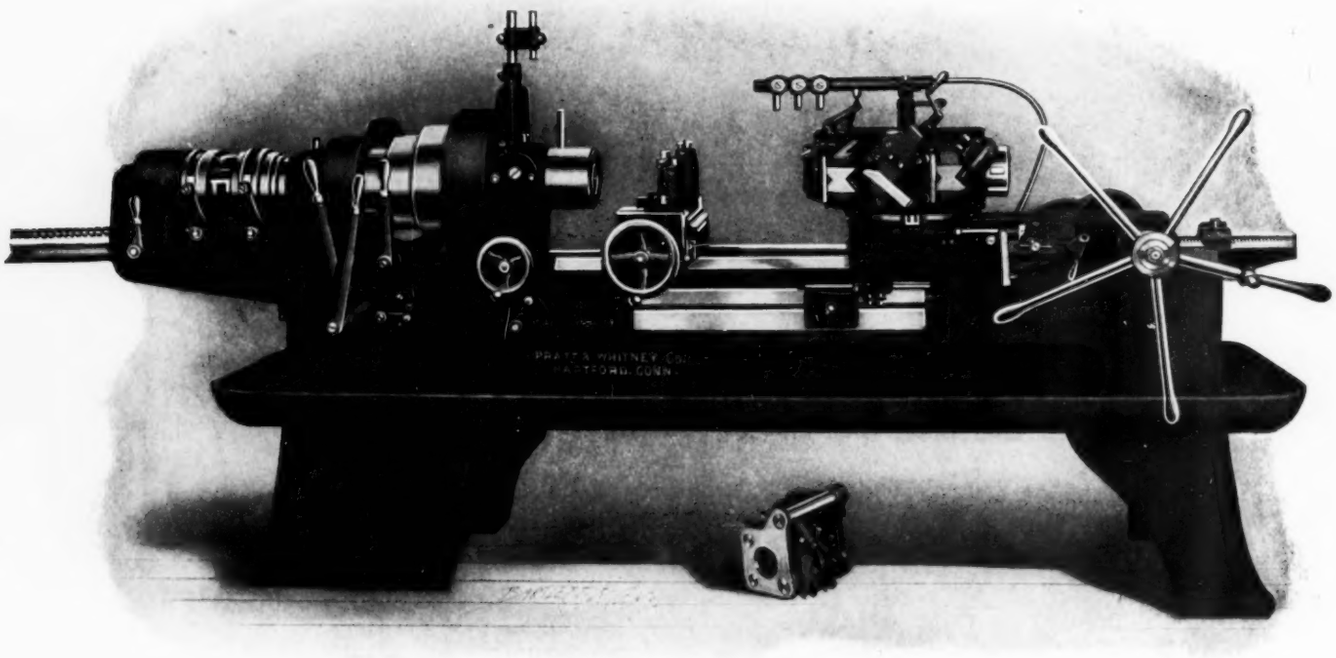

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Handling and Machining Large Engine Frames.

BY B. B. GAFFER.

The accompanying photographs are taken from what is computed to be the largest engine-frame castings ever attempted to be made in one piece. The camera followed the various operations from pouring the molds to loading on cars for shipment. In selecting the foundry floor space to mold these enormous castings, the application of the cranes and their capacity came in for a large share of consideration. Having a number of frames to make, experience had taught a whole pattern and core-boxes to be the most economical system, and suitable flasks were provided with numerous binders and connections. The whole outfit was erected in pits, brick and loam being employed for four feet of the molds, from which point dry sand mixture was used to complete them.

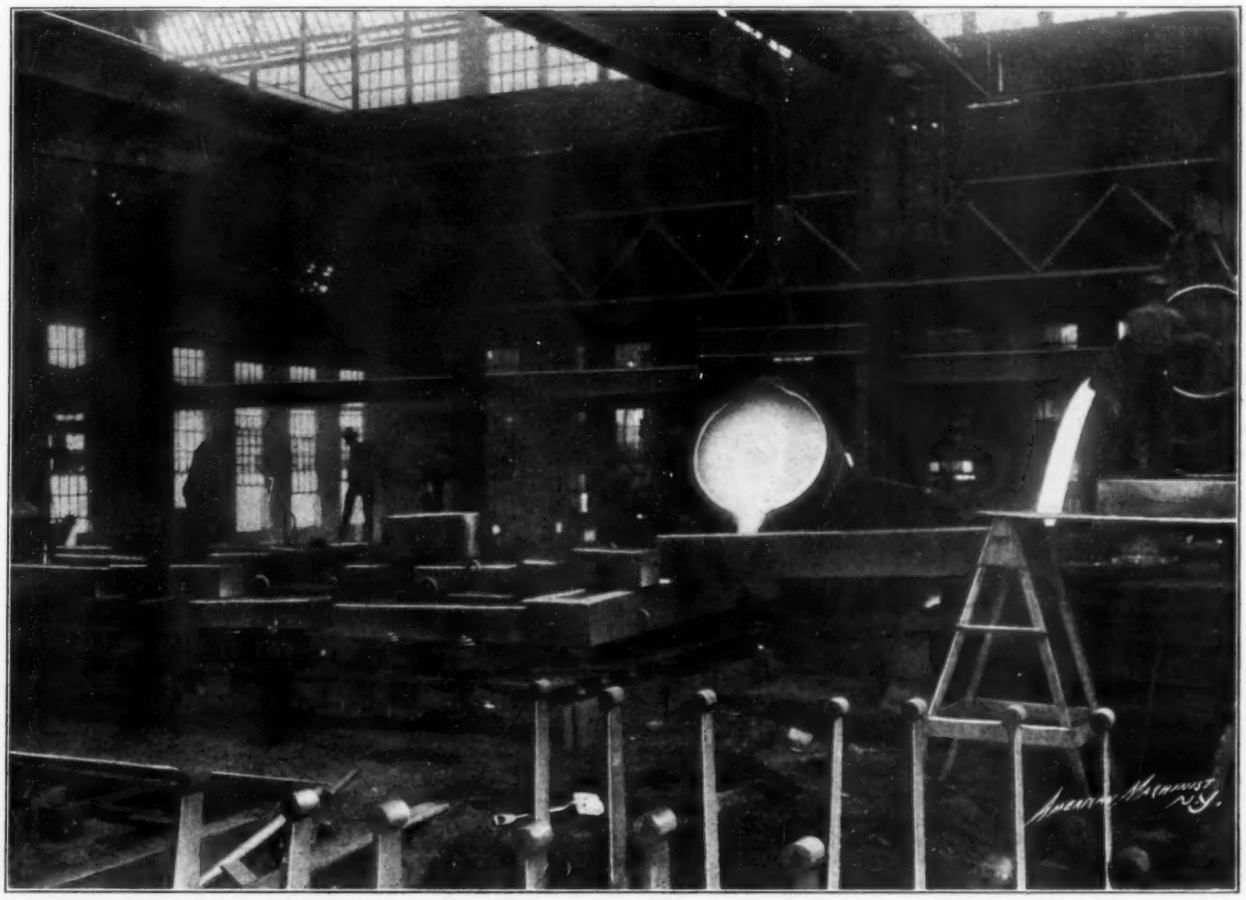


FIG. 1. POURING THE FRAMES.

The core racks were made of gray iron (grating pattern) with sufficient rigidity to sustain the load and with breakable portions to permit removal through small openings provided for cleaning and venting purposes. Ninety tons of pig and scrap were melted, requiring three cupolas to furnish the fluid material. Three 30-ton ladles poured their contents in dishes placed at the extreme ends of the molds, and betwen the signal to begin pouring and the joyful shout "up," six minutes had elapsed. The pouring of a mold is shown in Fig. 1.

Each casting remained undisturbed for ten days before the cope was removed. To facilitate removing the sand between the casting and flask, chains were laid horizontally in layers every two feet while sand was being rammed around the patterns, and, when the casting was ready to be dug out, these chains were hitched to the cranes, and as they were hoisted from the mold, they acted as ploughs, breaking up the hard, rammed sand into shoveling condition. In order to employ three cranes to lift the leviathans from the molding pits, special tackle had to be made, as shown in the background of Fig. 2. This lifting device hung from two cranes and was applied to take two-thirds of the weight, concentrating the capacity of two 30-ton cranes at the center of the lifting rig. A suitable hook for the third crane was attached as shown in the foreground of Fig. 2.

A temporary 10-foot-gage track was laid from foundry to machine shop. Four improved 10-roller trolleys carrying hardwood cradles, were employed to transport the castings to the machine shop. The rails had holes drilled in their treads for stop-pins used in connection with horizontal pushing jacks, all as shown in Fig. 3. These jacks are very powerful and with the trolley system make a very complete and rapid outfit for handling heavy castings. The weight of the casting was obtained by the method shown in Fig. 4. The casting was balanced at the definite points on knife-edge bearings near the end of the casting. One bearing was placed on top of a hydraulic ram, and when pressure was applied the tonnage was read by the gage. By reversing the position of bearings and ram, the sum of the two readings gave the weight of the casting.

In machining this casting, special tools and fixtures were required. After suitable floor plates had been laid on massive foundations, a lathe headstock of 14 feet swing was attached and doweled to the plate, as shown in Fig. 5. The center of the headstock was traced by a No. 23 piano wire and transit to a bar of steel permanently secured at a convenient position on the shop wall. A plate fitting in the recess of the face-plate of the headstock, having a hole in the center to fit the wire neatly and a V-shaped slot in the steel bar to receive the wire, established fixed points for

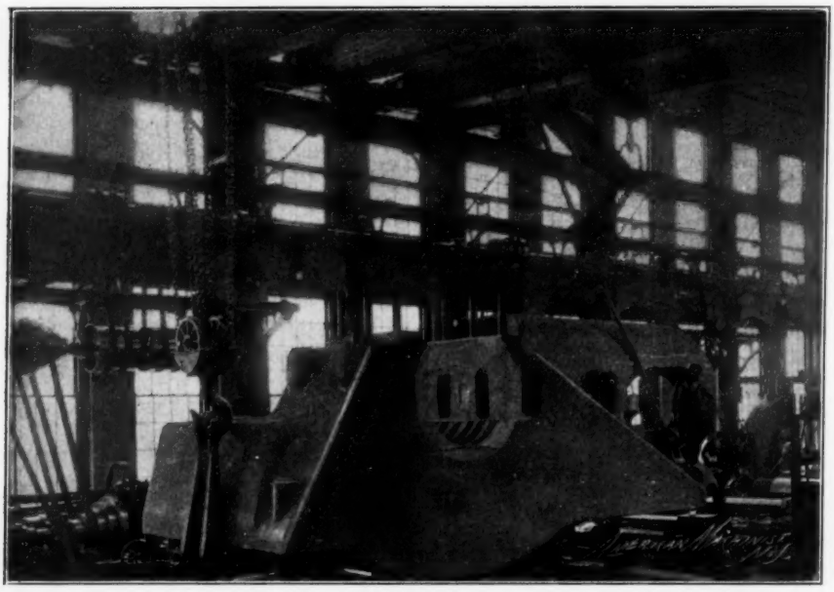


FIG. 2. THE LIFTING RIG.

the wire which could be easily placed and replaced with a certainty of being correct at all times.

With this wire as a center line the casting was set, consideration being given to the sag in the wire caused by its own weight. With a tension of 55 pounds on a 50-foot section of this wire, there remained a deflection of 1-32 inch, which condition was readily discovered with a transit. The boring bar used to bore the crosshead guides was 24 inches diameter and 17 feet long, made of gray iron with 4-inch walls and provided with a traveling head and screw feed. One end of the bar was secured rigidly to the face-plate with a flanged driving head, the other being supported in an adjustable ring bearing attached to the engine frame and adjusted with hollow screw bushings in the base of the ring bearing, as shown at *a* in Fig. 6.

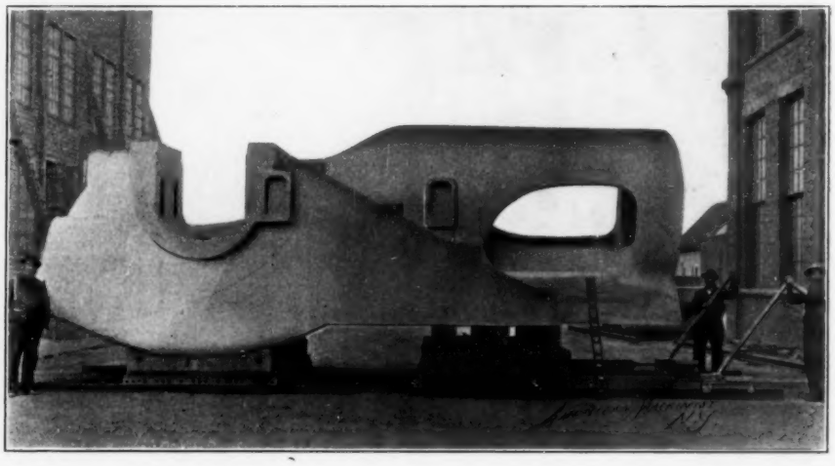


FIG. 3. JACKING THE CASTINGS INTO THE MACHINE SHOP.

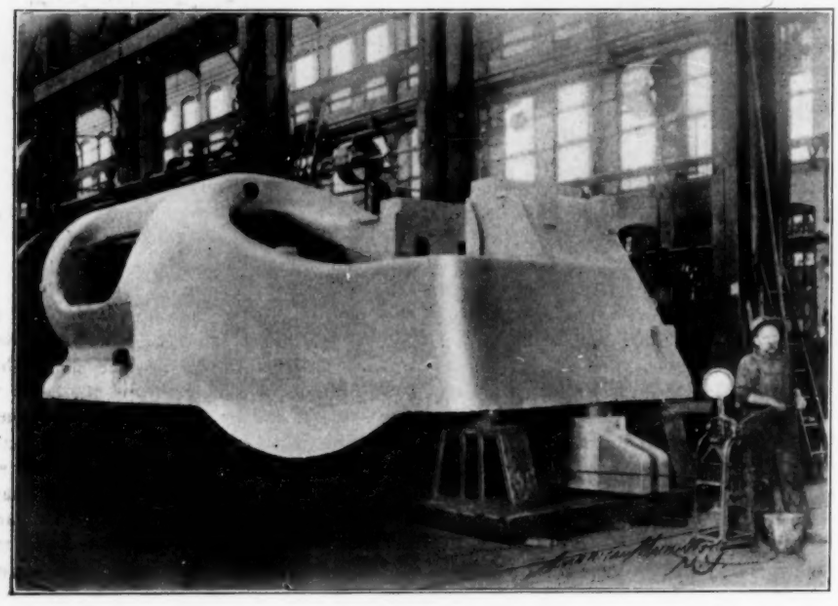


FIG. 4. WEIGHING A CASTING.

The hollow screw bushings were placed over two foundation holes in the crank-pit, and the whole outfit was held to the frame with two bolts passing through the screw bushing and frame. The special ring bearing was necessary, owing to the radial crank-pit having no opening in the bottom, making it impossible to use the ordinary tail-block for a bearing. With this bar constructed and mounted as described, there was a deflection, when bar was at rest, of 1-32 inch. A large portion of this objectionable feature is taken out of the bore of the guides by the bar assuming a more central position through the torsional strain to which it is subjected while the boring tools are removing the stock. However, there is always a corresponding amount of curvature in the finished bore of parts bored horizontally, due to the deflection of the bar, although this does no injury to the crosshead and piston rods, the main moving parts that would be affected when the engines are in motion.

Fig. 6 shows an additional bearing *b*, the presence of which is explained by the fact that it is the bearing ordinarily used for the bar when used for other jobs. It is fitted with the star feed rig (not shown in the illustration) used for feeding the boring head, and it was used on this job in order to make use of this feed.

In order to have the face of the frame square with the center line of the engine, an extra bearing was made to fit the crosshead guide and boring bar at the extreme end of the guide nearest the headstock. An additional spring bearing, Fig. 7, was provided with set-screw adjustment and was placed on the boring bar midway between the ring and the extra bearing. With this bearing in place the bar was withdrawn about 6 inches from face-plate and held in this position by two set collars placed one on each side of the extra bearing and secured to the bar to take up end play.

A tram, carrying a graduated gage, was then made fast to the driving head of the bar. The bar was rotated to two points vertically and two points horizontally.

These four points were at the greatest distance and of the same radius from the center of the bar. All four points were dressed to the same plane by hand fitting until each point showed the same reading by the micrometer. The headstock was then set to these four points, and a light cut taken from the face, making the finishing cut. The stock had been removed before this precautionary method of checking this face for accuracy was used. The spring bearing was used to remove the deflection from the bar while facing the cylinder fit and is a remedy to get an average alinement in horizontal engine work.

These castings are finished complete in one chucking, the various machines for

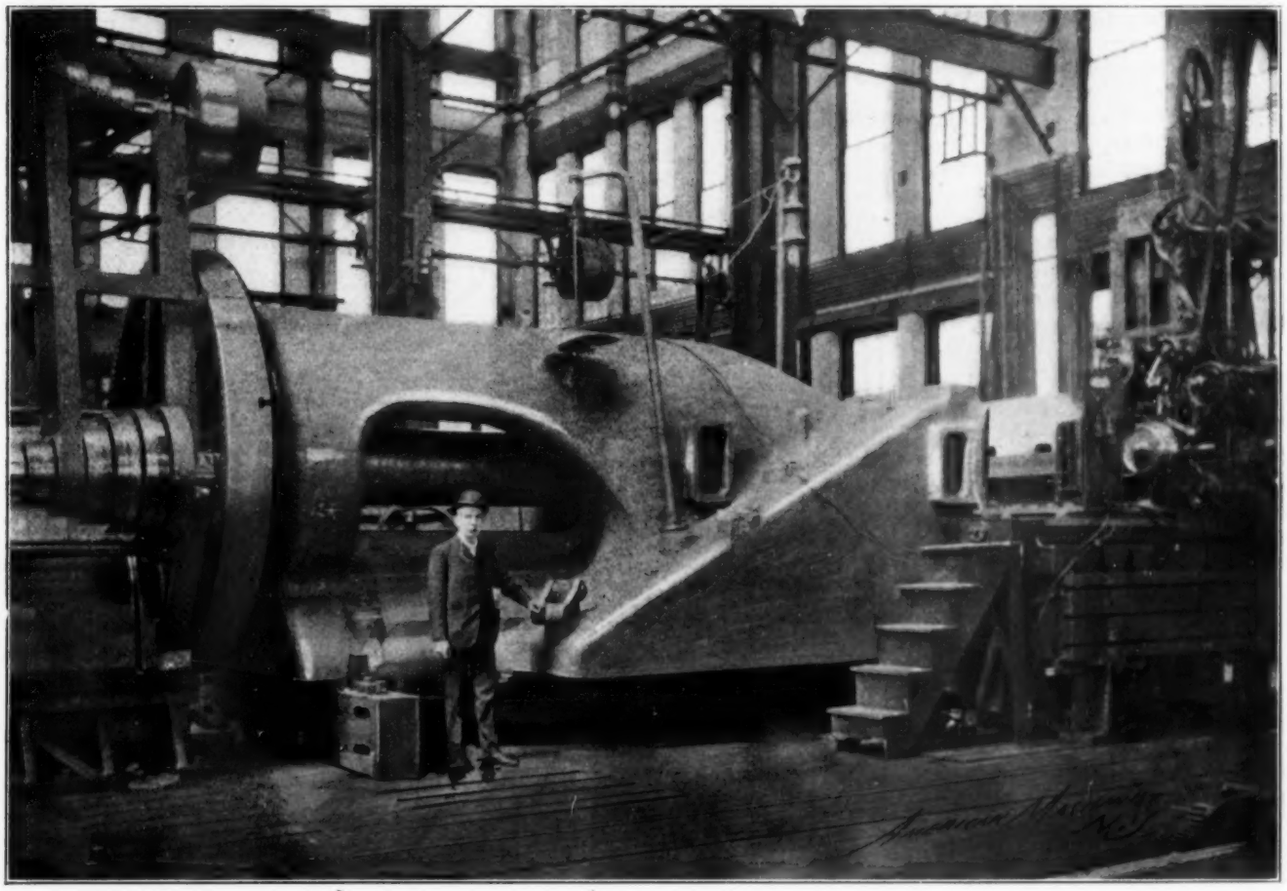


FIG. 5. FACING THE FLANGE, BORING THE GUIDES AND PLANING THE PEDESTAL.

different operations being brought to the castings, as shown in Figs. 5, 8 and 9. It was a case of "Mahomet going to the mountain." Excepting in one case, the tools were parts borrowed from standard machine tools in the shop with additional features made to meet the requirements. A portable shaper was used to machine the pillow-block jaws, as shown in Fig. 5.

A 6-foot radial drill was employed for drilling. The arm of this drill was pieced out to 12-foot swing, the extension being hinge-connected. The extension is arranged to be folded for short-ranged work, as shown in Figs. 10 and 11. For horizontal drilling, part of a Dallett portable drill was fitted to the saddle on the radial drill arm and driven through the medium of a bevel pinion socketed to the radial spindle. The outer end of the arm was saddled to a column, to prevent the arm from swinging, the saddle being free to move up and down on a groove fit to column, as shown in Fig. 12.

For boring the bottom and facing the ends of the pillow-block section, a special self-contained and self-setting rig fitting the planing and secured to the frame by the pillow-block cap-studs was used, as shown in Figs. 9 and 13. This fixture carried a boring bar with traveling head, screw feed and two facing arms. The bar was driven by a lathe headstock with a temporary motor drive, as shown in the background of Fig. 9, the headstick being mounted on the blocking-up pieces shown in Fig. 13. The pillow-block shells were machined and fitted to a duplicate box of pillow-block dimensions to insure duplication, as shown in Fig. 14.

All members of this large work were made to fit special fixtures and gages for securing interchangeable work. Fig. 14 is an example of these, and others are shown in Figs. 15 and 16. Fig. 15 shows the fixture used in boring the connecting-rod boxes, the space filled by the box representing the stub end of the connecting rod and Fig. 16 shows the jig for drilling the main bearing caps.

Manganese-Bronze and Its Manufacture. *

During the past twenty years, more interest has probably been displayed in manganese-bronze than in any other alloy. It was, perhaps, born at an opportune time, when a need for something of this nature was strongly manifested. Nations had realized the unrealibility of their bronze armament and the transition from bronze to steel had just begun. The fragile and weak gray-iron ship propeller, too, had begun to be the object of consideration. Implements of war, marine machinery, ordnance, and other forms of appliances were undergoing a period of improvement, and, in fact, a sort of metallurgical revolution was taking place. Again, such contrivances as torpedoes had begun to make their appearance. Then, too, the steel castings of commerce were of little value at that time. I feel quite sure, therefore, that the time was actually ripe for the advent of a strong alloy like manganese-bronze.

Manganese-bronze made its appearance on the market about the year 1876, and soon after aluminum-bronze began to be sold at a price which placed it within the

*Abstract from an article by Edwin S. Sperry in *The Brass World.*

reach of the marine engineer or other designer. For a number of years these two alloys, made by competitive companies and sold for the same purposes, became antagonistic to one another and many heated discussions took place in the trade papers about the relative value of the two alloys. Manganese-bronze finally won, and its use has increased until to-day its name has become almost a household word.

Manganese-bronze has practically driven aluminum-bronze out of the market, or to such an extent that the disparity in the quantities used is very great. This condition has taken place not because of the superiority of manganese-bronze over aluminum-bronze, but because it is cheaper (containing as it does nearly half zinc) and may be more easily cast. Unfortunately, aluminum-bronze is very difficult to cast in large sections. The extreme shrinkage, the large amount of dross, and the cost all militate against the extensive use of this valuable alloy. When a good casting of aluminum-bronze is made, however, it is superior in every way to manganese-bronze. I do not say this because I am prejudiced in any way, for I have had fully as much to do with one of these alloys as another; but for the reason that I firmly believe aluminum-bronze has met with defeat, not because of its lack of strength, not from unsuitability for all the work which manganese-bronze will do, not on account of its excessive cost, but for the reason that no one has yet mastered its casting so that successful castings may be continuously turned out. When this has been done, and at some future time it will be accomplished, aluminum-bronze will replace manganese-bronze as it has been replaced itself.

HISTORY OF MANGANESE-BRONZE.

Manganese-bronze is a misnomer. The uninitiated at once believe that it contains a large amount of manganese. The initiated know that it does not. It is not rare, indeed, to find manganese-bronze castings which answer specifications which contain no manganese at all. In fact, it is rare that over a few hundredths of a per cent. of manganese is found in manganese-bronze. The object of the manganese is not to act as an ingredient of the alloy, but as a carrier of the iron which must be present in the mixture to obtain the necessary strength and elastic limit.

As the manganese-bronze of commerce is known to-day, and as it exists on the market, it represents the invention of Perceval Moses Parsons, of London, England. The first record which we have of such an alloy is embodied in British

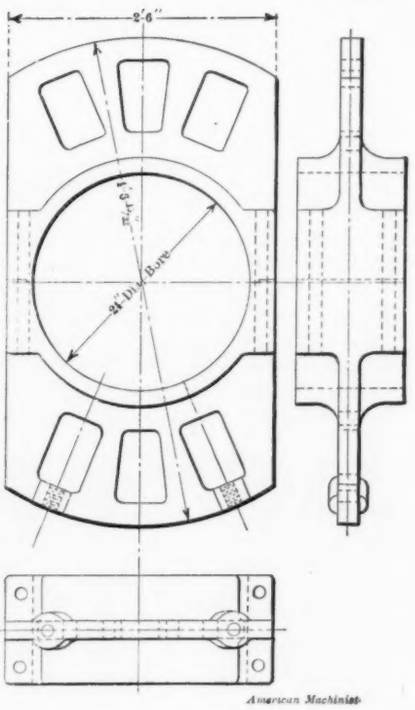


FIG. 7. SPRING BEARING FOR BORING BAR.

Patent No. 482 of February 1876.

The only claim which Parsons made was the introduction of the iron into the bronze through the agency of the manganese. The simple presence of iron in bronzes could not be claimed by him, as

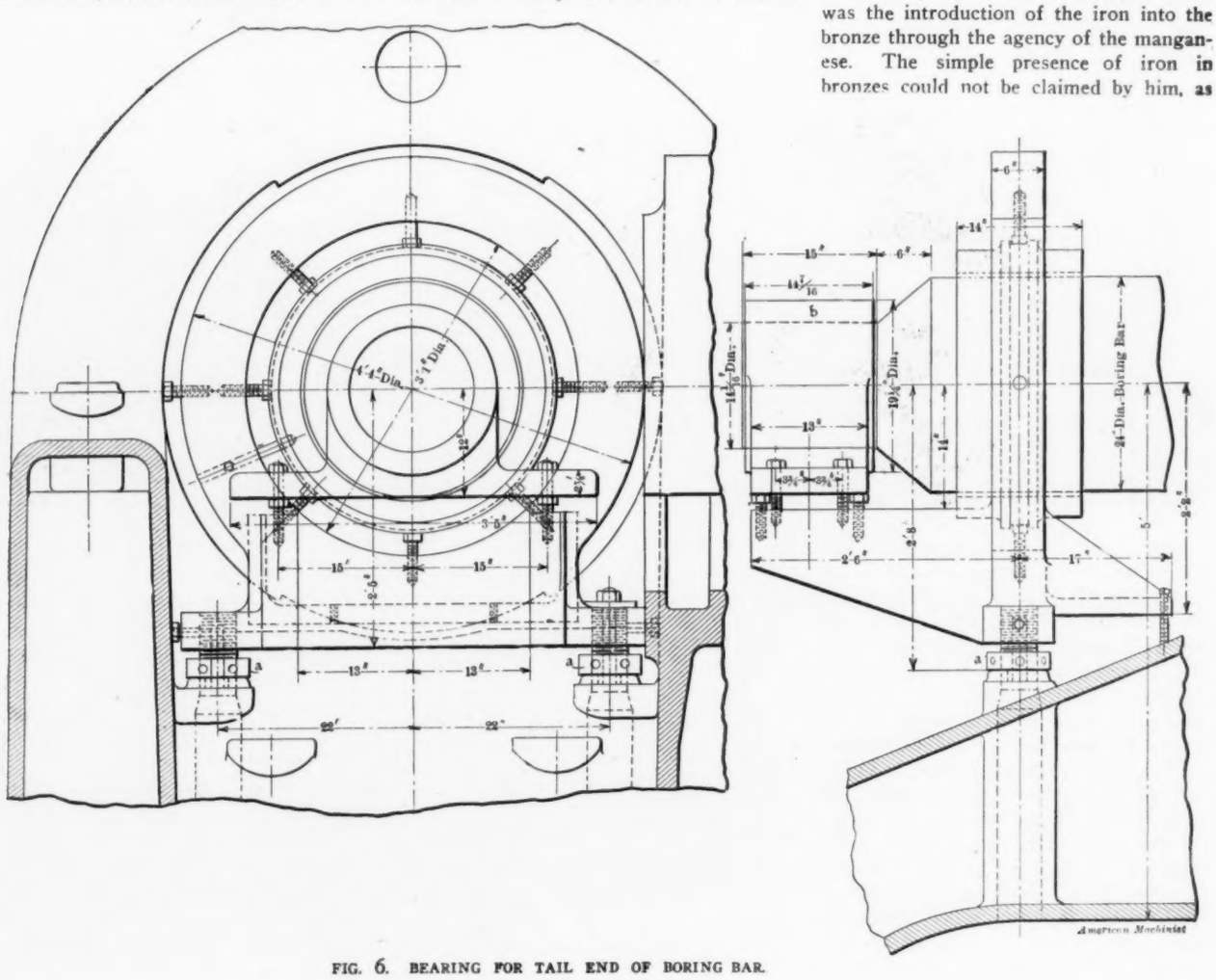


FIG. 6. BEARING FOR TAIL END OF BORING BAR.

it had been known long before this time that iron imparted strength to copper and zinc or copper and tin alloys. The well-known sterro-metal, Aich-metal, and several others of the same nature all contained iron. Parsons, however, did not attempt to claim such alloys, but the method of introducing the iron. In this his invention is novel.

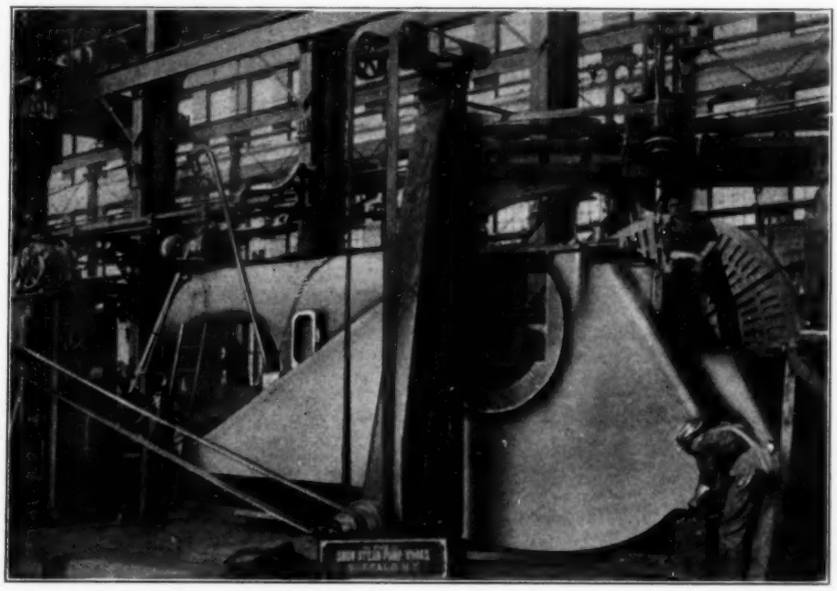


FIG. 8. DRILLING PEDESTAL CAP BOLTS.

As far as the preceding invention is concerned, I will say that the alloy which was produced by following its direction must have been disappointing as far as the copper and zinc alloys were concerned, because no one is able to cast alloys so high in zinc in sand molds with any success without other additions. In fact, Parsons' bronze, made after the preceding formula, was no better than the old sterro-metal which had been tried for sand casting purposes and found wanting. Parsons apparently realized that, while the iron which was introduced made the copper and zinc alloys very strong, the presence of so much zinc rendered it impossible to make sound sand castings. When it is known between 40 and 45 per cent. of zinc was added to the alloy, the difficulty of casting will readily be appreciated.

For some time, therefore, Parsons confined his attention to the copper and tin alloys to which the iron had been added, and propellers and similar forms of large castings were made from it. The alloys of copper and zinc with the iron content were used for casting in metal molds, for forging, and for rolling into sheet. No attempt was made to cast them in sand until apparently it was realized there was a possibility that some addition was necessary for the successful casting of the copper and zinc alloys. This addition was found in aluminum. In 1888, Parsons was allowed a patent for the addition of aluminum to the alloys enumerated in his former patent.

From this date on, the aluminum made it possible to successfully cast the alloys of copper and zinc in sand, and the copper and tin mixture was abandoned. It is without qualification that I am able to say the success of manganese-bronze, as made to-day, lies not so much in the iron which it contains, but in the aluminum. Before it was known that aluminum im-

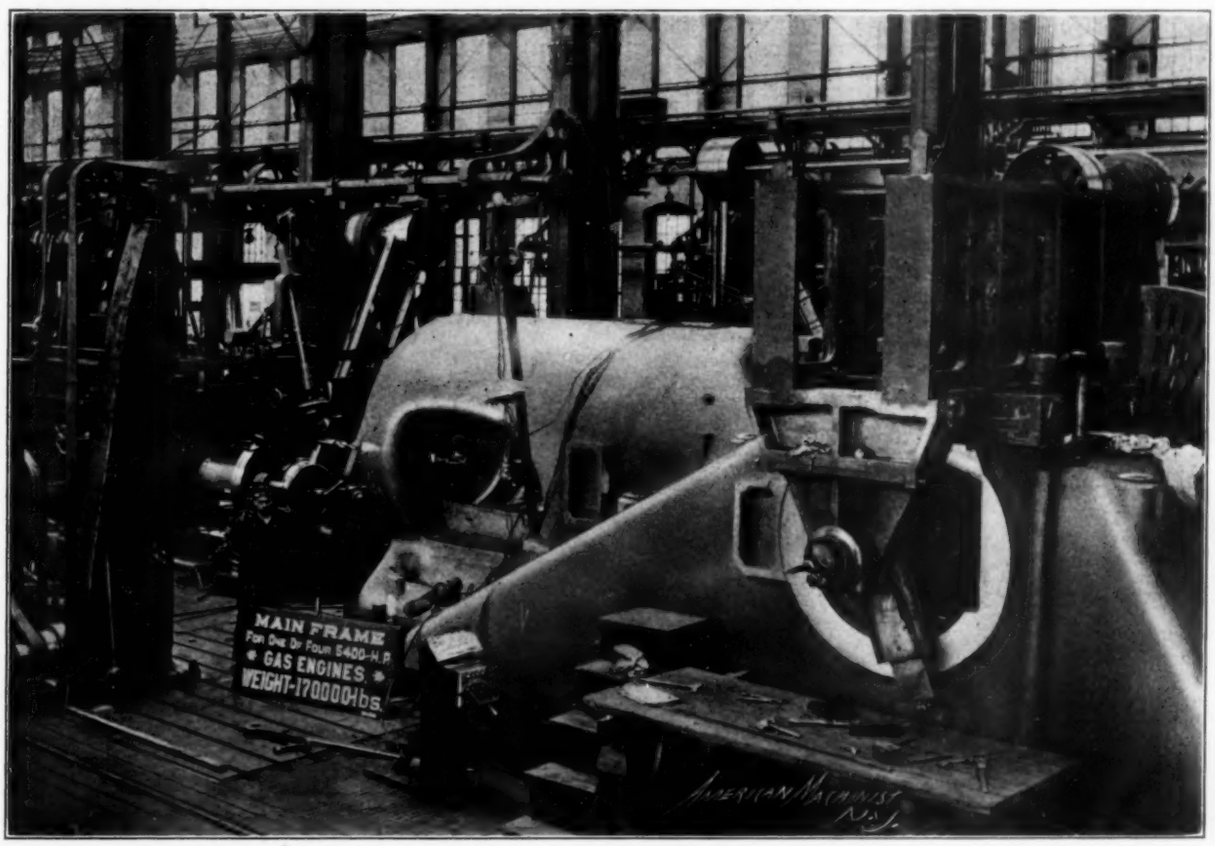


FIG. 9. BORING AND FACING A PEDESTAL.

parted a good sand-casting quality to the copper and zinc alloys high in zinc, manganese-bronze could scarcely be called a success.

After Parsons had been allowed his patent in Great Britain, one was granted a mixture for sand casting. This sand-casting mixture is the one extensively used for the manufacture of propellers and other well-known appliances. This sand-casting mixture contains aluminum to impart the necessary sand-casting qualities will give the results of analyses of samples which were made by the inventor. The results which I have obtained are as shown in the accompanying tables.

In theory, the functions of the various ingredients are as follows: It has been

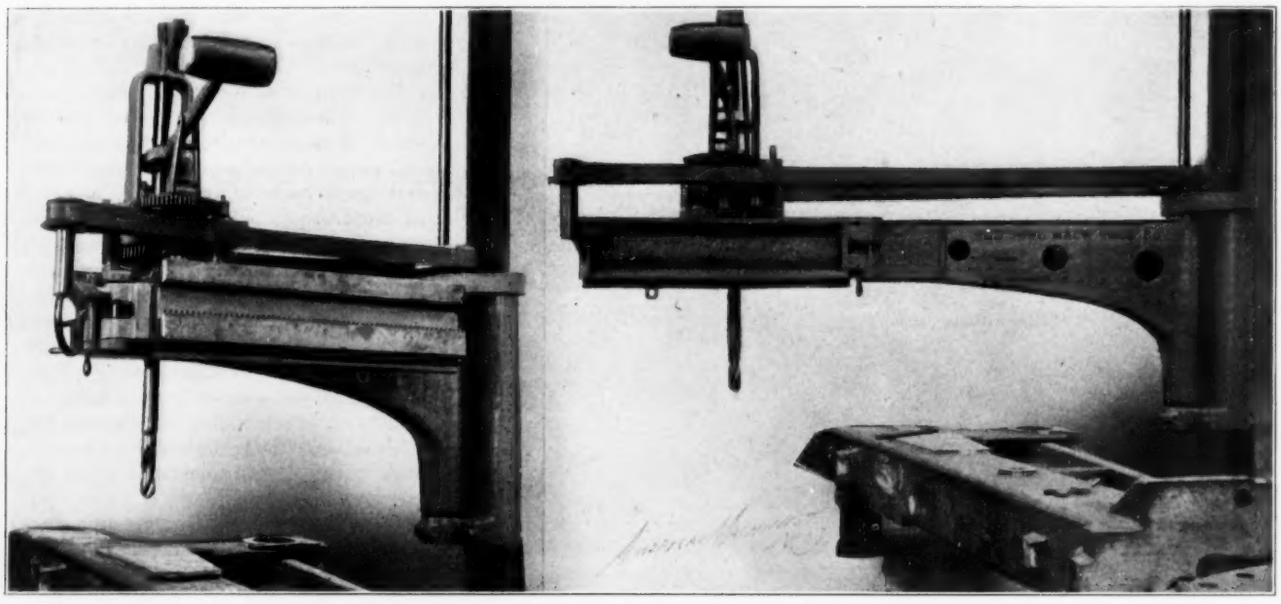


FIG. 10. FOLDING ARM OF RADIAL DRILL. FIG. 11.

him in the United States. This patent, No. 206,604, July, 1878, manufacture of alloys of manganese, P. M. Parsons, London, England, is a counterpart of the British Patent No. 842 of 1876. It will be seen that both of these patents have now expired.

THEORY OF MANGANESE-BRONZE.

The manganese-bronze of commerce is now practically confined to two grades: First, a mixture for rolling into sheet, or

ANALYSIS OF PARSONS' MANGANESE-BRONZE SHEET.

Sample.	No. 1.	No. 2.
Copper	60.27	60.02 per cent.
Zinc	37.52	37.70 " "
Iron	1.41	1.53 " "
Tin	.75	.72 " "
Manganese	.01	.02 " "
Lead	.01	.01 " "

ANALYSIS OF PARSONS' MANGANESE-BRONZE NO. 2.

(Ingots for Sand Casting.)

Sample.	No. 1.	No. 2.
Copper	56.11	56.23 per cent.
Zinc	41.34	41.16 " "
Iron	1.30	1.41 " "
Tin	.75	.68 " "
Aluminum	.47	.51 " "
Manganese	.01	none " "
Lead	.02	.01 " "

drawing into wire or tubes. This grade is also used for forging. As this mixture contains no aluminum, it cannot be cast in sand. The difference between this, the rolling mixture, and the mixture for sand casting is in the absence of aluminum and a slightly less zinc content. Second, to it, and without it the castings could not be made. This sand-casting mixture, however, is not suited for casting in metal molds, on account of the presence of aluminum.

In order to indicate the composition of these two grades of manganese-bronze, I found that the strongest copper and zinc alloy has the composition of about 55 per cent. of copper and 45 per cent. of zinc.

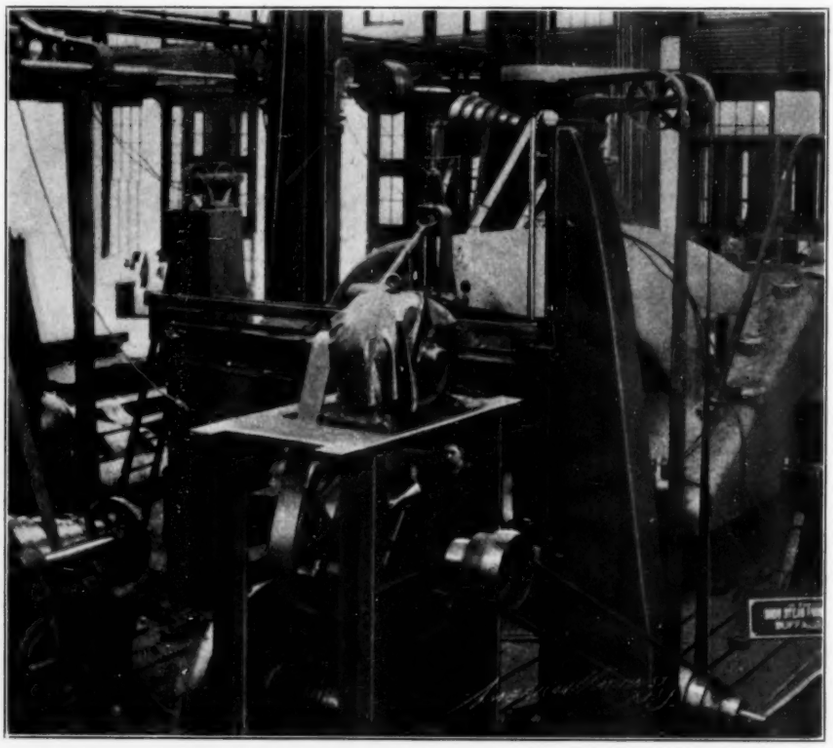


FIG. 12. DRILLING THE FLANGE HOLES.

The addition of iron to this alloy not only raises the strength, but the elastic limit as well. By adding the tin to this mixture, the elastic limit is well defined and

the strength increased. If too much tin is present, however, the alloy becomes brittle. From 0.50 to 0.75 per cent. of tin is all that is required. The aluminum is added to the sand-casting mixture for rendering it possible to cast the alloy in sand. Without it this would not be possible. The small quantity of lead which is present is introduced from the zinc. It will be noted that the amount of lead in both the sheet and the ingot is very small. This is brought about by the use of refined spelter. It has been found that common spelter contains enough lead to injure the strength of the alloy, and therefore, when the very highest strength is desired, together with the maximum elastic limit and elongation, only a refined spelter should be used.

The manganese in the alloy serves one purpose only: To introduce the iron. It acts as a carrier of the iron, and without it the iron would not alloy with the copper. All brass-foundrymen know how difficult it is to thoroughly incorporate iron with copper or brass. If metallic iron is melted along with copper or brass, part enters the alloy and becomes chemically combined, and the remainder separates in pellets or nodules of the hardness of steel. These nodules are the source of much trouble in brass, as they injure tools to an alarming extent. By the use of manganese and iron together, the iron may be made to alloy perfectly with the copper, or copper and zinc, without any danger of the steel-like nodules separating. This is the real function of the manganese, and it has no other use. If added in large amounts, it hardens the mixture, but not nearly as much as the iron. At the same time the mixture is deficient in elastic limit. The iron seems to be necessary to produce this.

The manufacture of the ingots of manganese-bronze is the first step. It has become a well-established fact that the mixture must first be poured into ingots and then remelted and poured into castings. The first melt does not give good castings. I will describe each step in the manufacture of the manganese ingot. The first process is the production of the "steel-alloy," as it is called, by means of which the iron and tin are introduced into the alloy.

MAKING THE "STEEL-ALLOY."

Ferro-manganese is used in the manufacture of steel to promote soundness. It consists of about 80 per cent. of manganese, about 14 per cent. of iron, and about 6 per cent. of carbon. Other ingredients, such as sulphur, silicon and phosphorus, are present in small quantities. This ferro-manganese is used in the manufacture of manganese-bronze and it is the base of the whole operation. Spiegeleisen

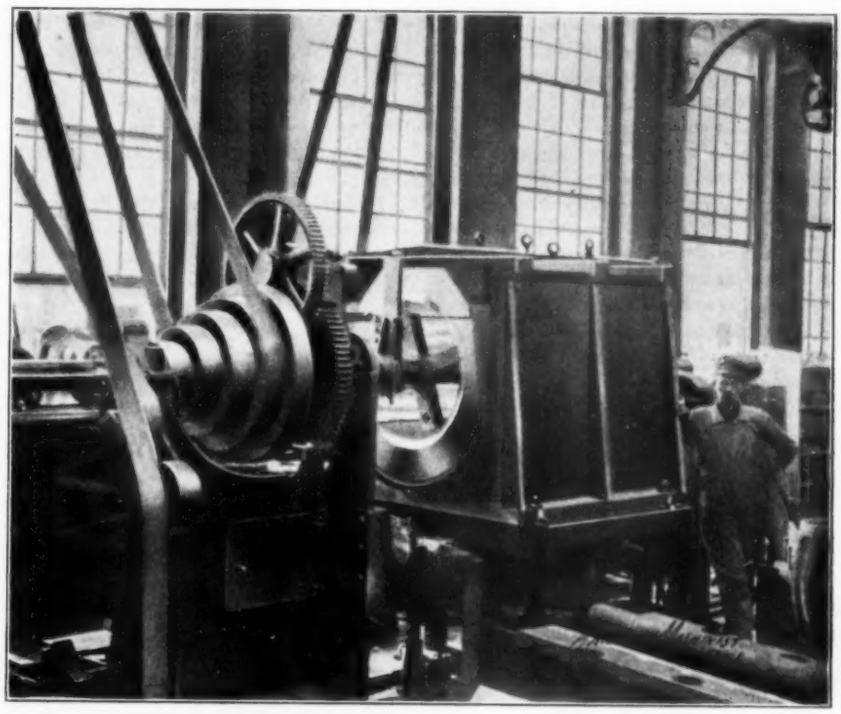


FIG. 14. BORING PILLOW BLOCK SHELLS.

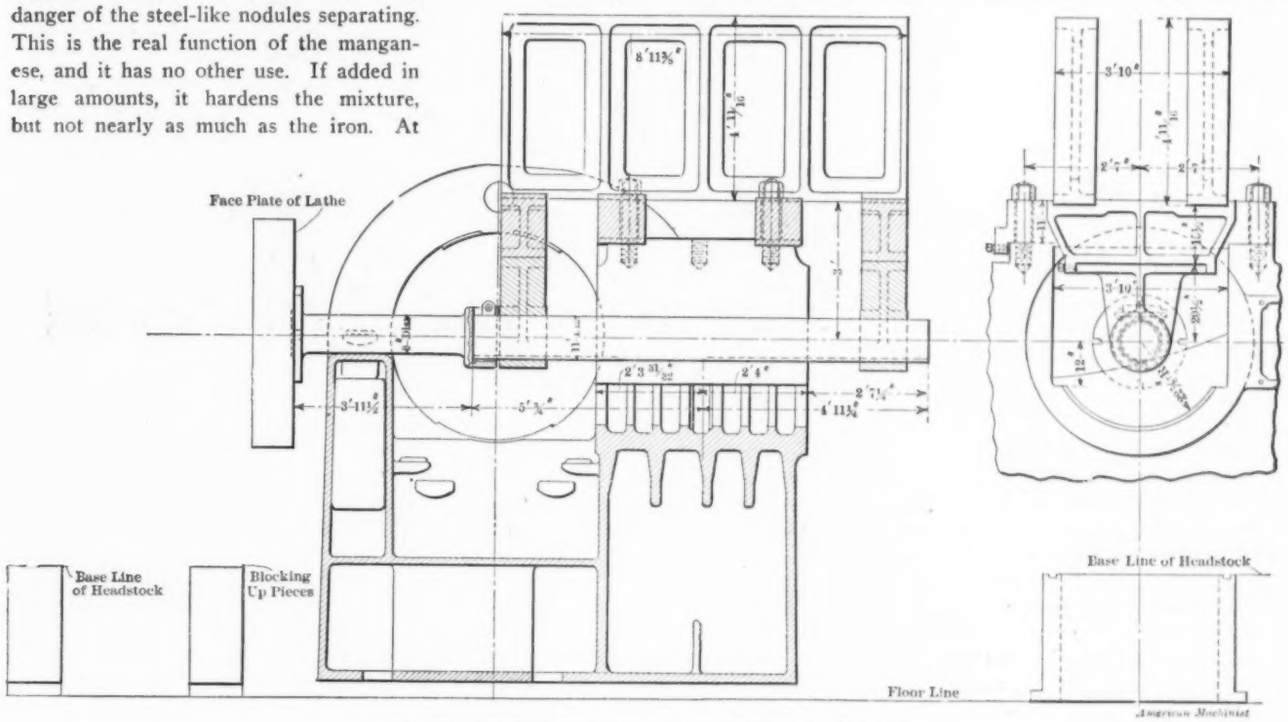


FIG. 13. FIXTURES FOR BORING AND FACING PEDESTAL.

is an alloy of about 80 per cent. of iron and 20 per cent. of manganese, and may likewise be used for making the "steel-alloy," but the ferro-manganese is readily obtained and is generally used. The ferro-manganese is found on the market in lumps and is easily broken. It is not expensive and as so little is used the cost is of little importance.

The ferro-manganese is melted with pure wrought iron. This wrought iron should be in small pieces, and the best form is in small pieces of rods which have been cut. As Norway iron is the purest form of iron on the market, it is to be preferred, although any other form of wrought iron will answer. I cannot recommend fine iron wire, as the oxidation is too great in melting. I have been accustomed to use half-inch Norway iron rods which have been cut into small bits so that the pieces will pack well in the crucible. The iron and manganese alloy is made as follows:

Wrought Iron	18 lbs.
Ferro-Manganese	4 lbs.
Tin	10 lbs.

The iron and the ferro-manganese are put in a graphite crucible together and covered with charcoal. They are then melted as rapidly as possible. It is well to cover the crucible with a lid, as the melting then proceeds more rapidly. The fire must be urged to its utmost capacity to melt the iron and the ferro-manganese, and when this has been done an iron rod (previously made red-hot to avoid chilling the metal) indicates that all the lumps have become liquid, the tin is added and the whole stirred. A plumbago stirrer is preferable to the iron, as there is then no danger of chilling the liquid metal.

When all has been melted, the metal is poured into small strip ingots so that they may be readily broken up. They will be found to be quite brittle, so that no difficulty will be experienced in breaking them. This "steel-alloy" which is thus produced is used for melting with the copper.

MAKING THE MIXTURE.

The mixture for the manganese-bronze is made as follows:

Ingot Copper	56 lbs.
Bertha Zinc	43 lbs.
"Steel-Alloy"	2 lbs.
Aluminum	½ lb.

One ingot (or about 15 lbs.) of the copper is put in a crucible and melted under a good covering of charcoal. The heat of the copper should be brought to a bright red. Now add the "steel-alloy" and stir. If the "steel-alloy" does not melt, the heat must be raised until it melts and alloys with the copper. When this is done, add the aluminum. When the aluminum melts and alloys with the copper considerable heat will be generated by the combination. This will serve to liquefy any of the "steel-alloy" which may not have alloyed with the copper. The whole should be thoroughly stirred at this point.

The remainder of the copper is now added and allowed to melt, and, after stirring again, the zinc is added. The whole is now once more stirred and the metal then poured into ingots. Care should be used not to overheat the copper so that there is a large loss of zinc. I have made allowance in the preceding formula for a waste of one and one-half per cent. of zinc in two meltings so that the sand casting will contain approximately 56 per cent. of copper.

The preceding mixture will be resolved into the following percentages after the 1.5 per cent. of zinc which was allowed for waste has been deducted:

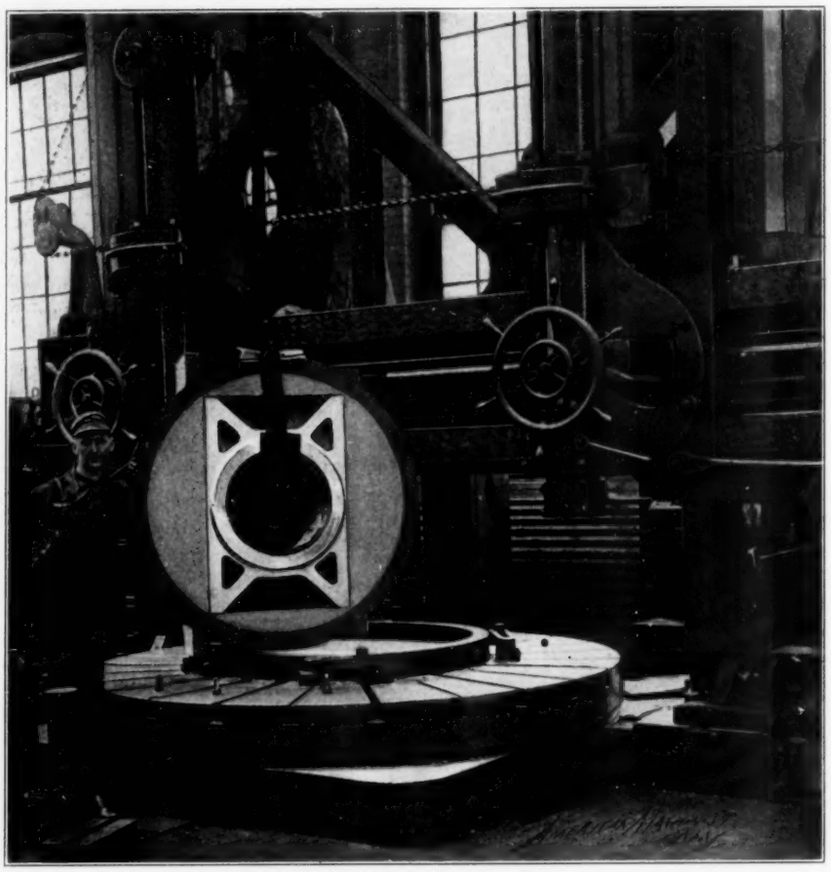


FIG. 15. FIXTURE FOR BORING CONNECTING-ROD BOXES.

PERCENTAGE - FORMULA FOR MANGANESE BRONZE.

(For Sand-Castings.)

Copper	56.00
Zinc	42.38
Iron	1.25
Tin	.75
Aluminum	.50
Manganese	.12

As previously stated, a sufficient quantity of zinc has been added to allow for the waste of two meltings; but in case the metal is melted more than this number of times, 1 lb. of zinc should be added every time the melt is made. This will compensate for a moderate loss. If the bronze is allowed to overheat, from 2 to 3 lbs. to 100 lbs. of metal will have to be added.

CASTING IN SAND.

While the making of manganese-bronze is the most important part, it is necessary that great care is bestowed upon the casting of it. Unless this is done a good ingot metal will never produce strong castings. The most particular part of the casting is the melting.

Let me say at the start that it is very poor policy to have the metal ready before the molds are finished. In this manner metal is allowed to "soak" in the fire and is ruined. In melting, the metal should be well covered with charcoal and not allowed to become any hotter than is necessary for the pouring of the casting. It is a mistake to believe that an overheated metal can be brought down to the right heat by means of gates and still have it as good as when it is not allowed to overheat. Metal of this kind will never give castings with a high tensile strength.

As manganese-bronze contains so much zinc it melts easily, and it is very easy to overheat it. For large castings the metal is ready before it "flares." In this instance, the surface will flare very slightly when disturbed with a skimmer. In this condition the metal is ready for pouring, and one will be surprised how much better results may be obtained than with overheated metal.

For small castings it will frequently be

necessary to have a slight "flaring" of the zinc upon the surface of the melted metal in order to make certain that the castings will run. It is surprising, though, how "dull' the manganese-bronze may be poured and still have the casting run. The best results are invariably obtained by not allowing the metal to get any hotter than is necessary for the "running" of the casting. Metal poured as "dull' as possible is invariably the best.

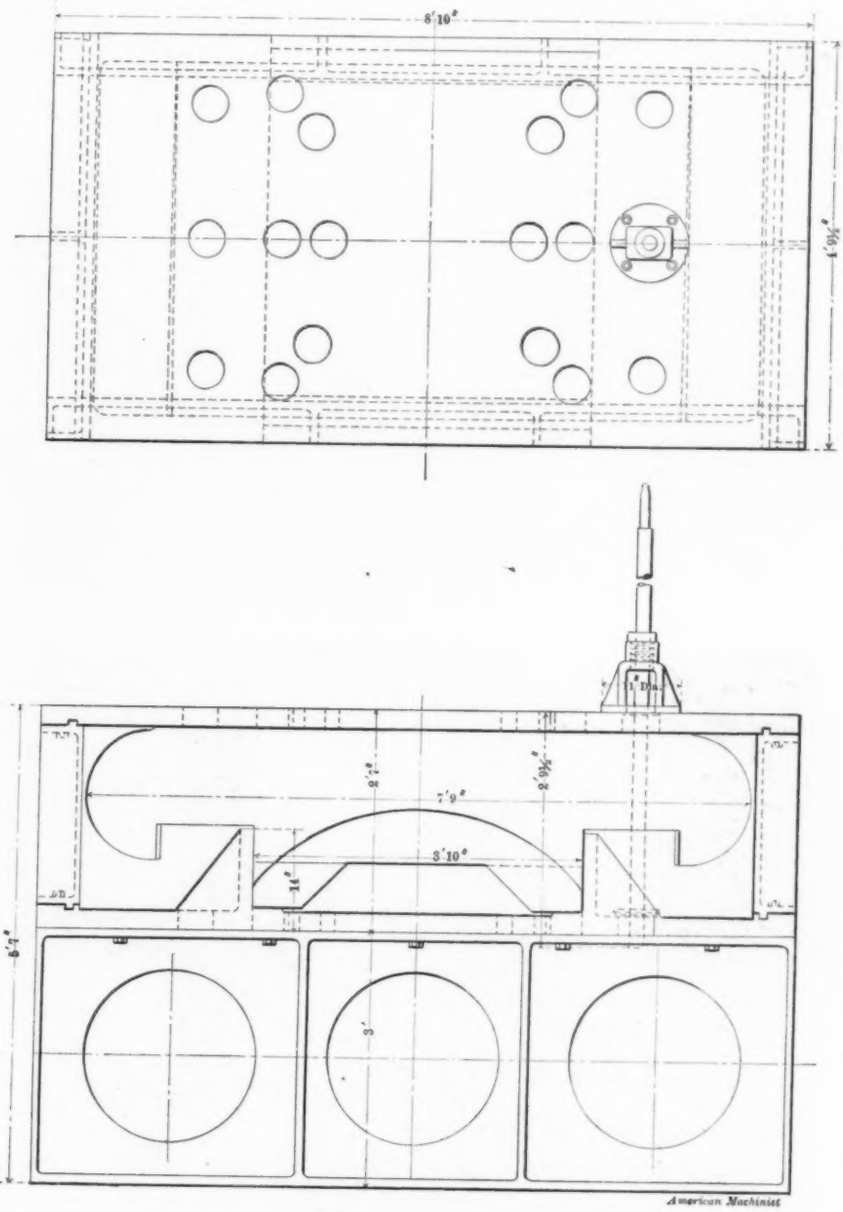


FIG. 16. JIG FOR DRILLING MAIN BEARING CAPS.

The use of manganese-bronze in propeller wheels is now its largest consumption. Here it is necesary that a strong, tough alloy be used, and one which will resist the action of sea water. Manganese-bronze propeller blades are now made very thin, so as to save weight.

Most propellers are now cast with separate blades, as this method allows broken blades to be replaced. The casting and molding difficulties are likewise decreased.

TEST BARS.

As manganese-bronze is a strong metal and is used to meet the special requirements that are found in large engineering problems, nearly all of the castings which are made are required to come up to specifications. Test bars made from the mixture previously given and cast in green sand have repeatedly given the following:

Tensile strength .....70,000 lbs. per sq. in.
Elastic limit .....30,000 " " "
Elongation in 6 inches.....18 per cent.
Reduction of area .....26 " "

I have given the preceding tests merely to indicate what can be accomplished, as space will not now allow me to go into greater detail about the casting of test bars. In a later paper it is proposed to take up the casting of manganese-bronze and explain it more fully. This paper is intended to enlighten the reader upon the making of the ingot metal.

MANGANESE-BRONZE SHEET AND FORGINGS.

The mixture which is used for this purpose is practically the same composition as that which is used for sand casting except that it contains no aluminum. The copper is also increased until the mixture is practically Muntz metal. This is necessary, in order that the metal may not be too stiff when rolled.

The following mixture may be used for rolling into sheet, forging, etc.:

MIXTURE FOR MANGANESE-BRONZE SHEET.

Copper .....60 lbs.
Zinc .....39 lbs.
"Steel-Alloy" ..... 2 lbs.

The "steel-alloy" is melted with one of the copper ingots in the same manner as before, and then the zinc is added. In this manner it is possible to avoid the excessive loss of spelter. As this mixture contains no aluminum, it need not be melted twice, and castings may be poured from it at once. The casting of it in iron molds is carried out in the same manner that brass is cast. Allowance is made in this mixture for a loss of one per cent of zinc. If great care is not taken to keep the loss of spelter down in casting this mixture, the copper will increase to such an extent that hot-rolling cannot be done upon the metal.

The mixture for sheet rolling in percentage gives the following:

Copper .....60.00 per cent.
Zinc .....38.00 " "
Iron ..... 1.25 " "
Tin ..... .65 " "
Manganese ..... .10 " "

This mixture may be rolled both hot and cold and may also be used for forging purposes.

To control the hardness of manganese-bronze the "steel-alloy" may be varied. If a mixture with more elongation is needed then less of the "steel-alloy" is added. More gives a harder alloy and one with less elongation and reduction of area.

The manganese in the mixture is usually oxidized out in one or two meltings, if not before. This accounts for the small percentages which are found in commercial manganese-bronze. The manganese may be shown in an analysis of the manganese-bronze, but it has done its work in deoxidizing the copper and allowing the iron to become incorporated in the alloy. In manganese-bronze as made at the present time, manganese has no other action.

It may not be as bad practice to use a monkey wrench for a hammer as it is to use the hammer as a monkey wrench, but neither practice needs any encouragement.—*The Wood-Worker.*

Some Large Gate Valves.

Some time since, the Pratt & Cady Company, of Hartford, Conn., were asked to construct some gate valves of 9 ft. water-way, and as they had no machinery adequate to the work, they naturally hesitated somewhat; but after a little study, it was deemed best to make the attempt.

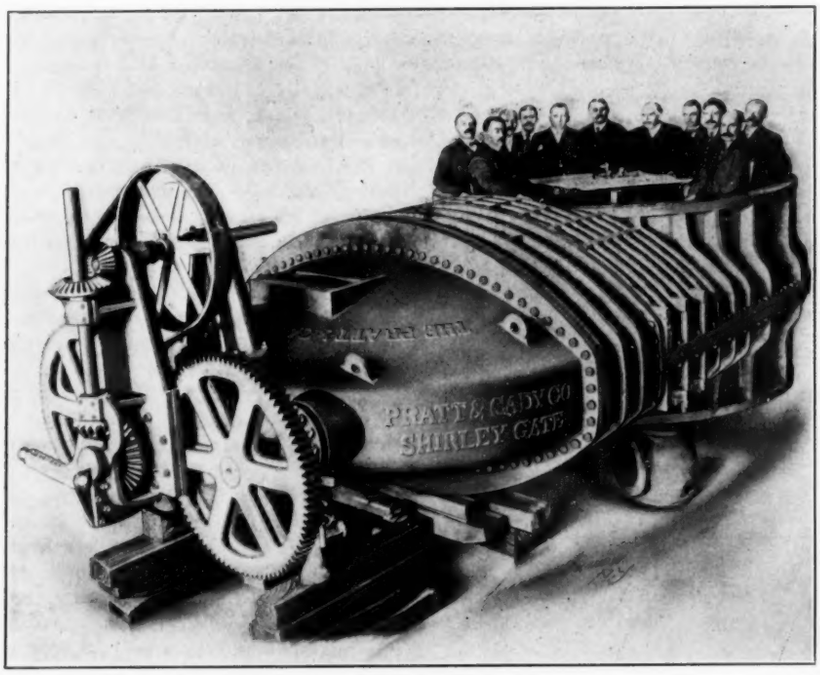


FIG. 1. THE COMPLETE VALVE.

While sluice valves have been constructed, having openings larger than nine feet, a nine-foot valve remains the largest and heaviest gate valve yet attempted; weighing as it does, when complete, 126,000 pounds, and at 50 pounds per square inch, holding a pressure on its gates of 204 tons.

It will already be seen, from this, that the entire valve must be of substantial construction and thoroughly bolted. The body was made in halves to facilitate handling, each half weighing 26,000 pounds nearly. The two halves were bolted together with two rows of bolts, one row containing seventy inch and a quarter bolts in the outer flange, and one row containing seventy-five one-inch bolts in the inner flange, inside the body. The neck, or part between the body and cover, as well as the cover, was bolted with 1¼-inch bolts spaced about 4½ inches on centers.

The gates consist of two disks 112 inches in diameter, having bronze faces about 3½ inches wide and ½ inch thick screwed and riveted thereto. The locking, or wedging, is accomplished by means of bronze wedges, the same as ordinarily used in gates of this type.

The operating screws, of which there are two, are 4 inches in diameter and 12 feet long, of solid Tobin bronze, working in bronze nuts secured in pockets in the gates.

The valve is opened and shut by means of a 30 horse-power motor, bolted to the bonnet, and connected by a train of spur and bevel gears to the spindles, the ratio of gearing being 15 to 1. This motor is not shown in the half-tone as it was applied on the ground where the valve was installed, the pulley shown being to operate the valve in the factory during the tests.

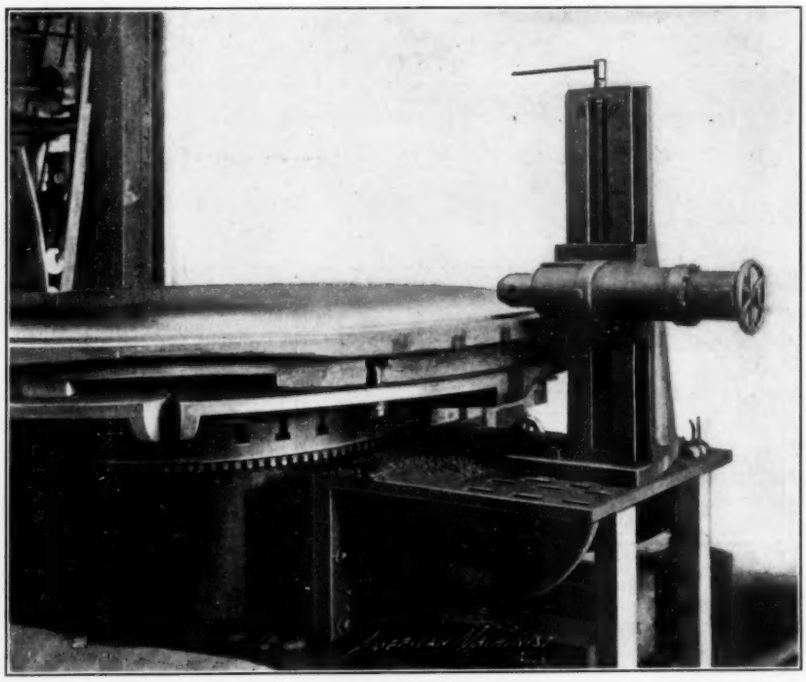


FIG. 2. THE EXTENDED BORING MILL.

As the largest planer in the factory was only 42 inches square, all castings had to be made with that in view, thus adding somewhat to the difficulties encountered.

The largest boring mill in the factory was of 62 inches swing, and this was stripped so that all that was left was the base casting and table. The base was bolted firmly to three 12-inch square yellow pine timbers, and these in turn were bolted to the floor to obtain a broad and stable base. Then two castings were bolted to the sides of the base where the uprights came off, and to these two angle plates 42 inches square and high were fastened, as shown in Figs. 2 and 3, thus making a platform about 12 feet wide from side to side, and 42 inches from front to back with the table of the mill standing in the center. A special headstock was then constructed to make the proper reductions in speed, to which a ten horse-power motor was bolted. In making this headstock, it was necessary to keep all the gears and pulleys small enough so that none should project above the table of the mill.

A series of triangular pieces, eight in number, were bolted to the table of the mill, thus making a table about 10 feet in diameter. To this were secured the various circular pieces, such as the brass rings, disks, etc., while they were machined, the tools being held by a specially constructed housing which was bolted to one of the angle plates before mentioned. The arrangement of the side pieces, angle plates, triangular sections and special housing are all shown in Fig. 2.

As the rings which formed the seats had to be screwed into the body, it was

necessary to cut a thread on them, and this was done by allowing the vertical screw in the housing to pass through the angle plate, where a miter gear was keyed on it, and from that a horizontal shaft extended back parallel with the headstock spindle, to which it was connected by a chain and sprockets. As the drive was so proportioned that the screw revolved at the same rate as the table, it follows that the thread cut upon the ring was of the same pitch as the screw, which in this case was eight per inch.

After all the circular parts which could be machined in this way had been finished, the triangular pieces were removed from the table and a rectangular piece, just long enough to turn inside the body of the valve was substituted, and the same housing was bolted to this; the body being secured to the angle plates and the work being done with the body stationary and the tools in motion. The mill had also to be reversed for this operation, in order that the thread cut might be of the same hand as that on the rings.

The threads inside the body were cut by putting a stiff shaft through the hole in the center of the table of the mill to the floor. A socket with a square hole, which received the squared end of the shaft, was bolted to the floor, thus preventing its shaft from turning with the mill. To the top of the shaft was keyed a miter gear, and a transverse shaft connected this gear with a miter gear on the top of the housing feed-screw.

As the central shaft was stationary, it was evident that the gears traveling around it would cause the screw of the housing to rotate at the same rate as the table, thus, of course, duplicating the thread already cut on the rings. The threads produced in this way were good, and when the rings were screwed home the joints were found to be perfect, and no leaks occurred at testing.

The joint between the halves of the body were faced with this same arangement as far out as the tool could be made to reach, which, of course, left the straight portion above the circle, shown in Fig. 4, at *a a*, rough. This was afterward milled off on a horizontal milling, drilling and boring machine on which the joints between the body and neck, and the neck and cover, were milled.

Perhaps the housing may be of enough interest to call for a word of explanation. As it was only to serve its purpose for these few valves, no refinement of construction beyond what was absolutely necessary could be allowed. As it was to be used for both the outside and inside of the work, in the first case standing still while the work revolved, and in the second case revolving while the work stood still, it had to be both right and left hand.

The principal casting was a simple angle plate, with quite a broad foot to resist side strains and to allow the upright to get close to the work. It will be noticed in Fig. 2, that one side of the foot of the housing was cut off on an angle, in order to provide clearance, while the housing was inside the body. The bevel part of the vertical slide that carried the saddle was made in a separate piece, and was fastened to the angle iron by means of machine screws, as is plainly shown in Fig. 2. By removing these screws and turning the slide upside down, the tool slide was, of course, reversed.

The tool bar was simply a gray-iron casting, 5 inches in diameter, fitted into a carefully bored hole, and prevented from turning by two 7/16-inch square keys. This bar was advanced or withdrawn in exactly the same way as the tailstock spindle of a lathe. Two holes, drilled through the end of the bar, at an angle of 45 degrees to its axis, received 7/8-inch round self hardening steel cutters. Of course all feeding had to be done by hand.

It will be noticed that in reversing the vertical slide, the bottom of the screw on which was keyed the miter gear, would come to the top, thus allowing the same train of gearing to be used on the internal work as that used on the exterior work.

These valves were for the Niagara Power Company to control the flow of water in their penstock of their new plant, on the Canadian side of Niagara Falls.

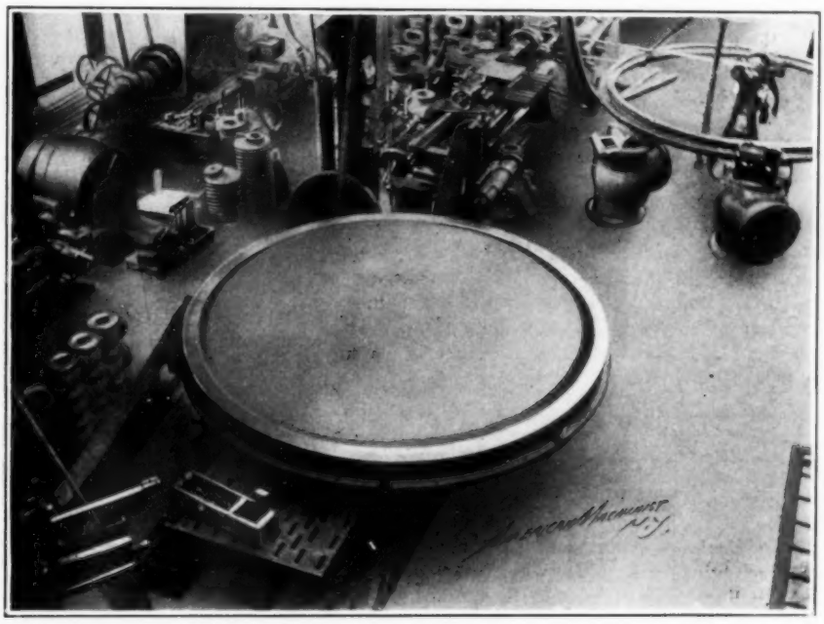


FIG. 3. FACING A GATE.

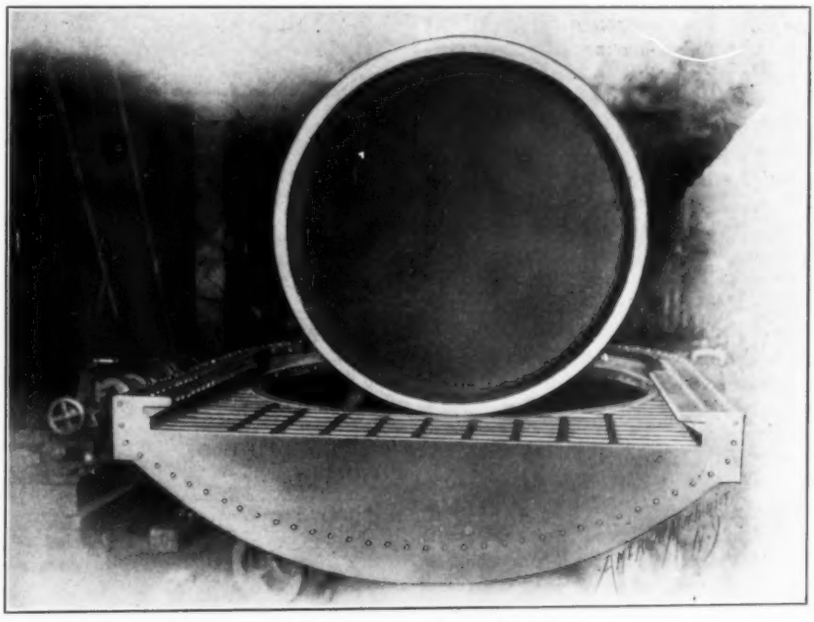


FIG. 4. ONE HALF OF BODY AND GATE.

Compound Air Compression.

BY LUCIUS I. WIGHTMAN.

It is well known that the heating of air produces an increase in its volume, whatever the source of the heat. The heat produced in a cylinder by compression acts to expand the air in that cylinder, whatever the speed or rate of compression. In effect this is equivalent to an increase in the volume of air to be compressed and delivered. This in turn calls for an increase in the power, to compress this apparently added volume of air; or, to put it differently, the heat of compression, in increasing the volume of air, makes it necessary to carry the air to a higher mean effective pressure in the cylinder, in order to secure finally the required volume of air at the required pressure after its temperature has fallen to that of the surrounding atmosphere, requiring, therefore, an excess of power. A consideration of these facts suggests that if some means be provided for removing the heat of compression as fast as it is produced, there will be an important reduction in the power required to raise a given weight or volume of air to a given pressure.

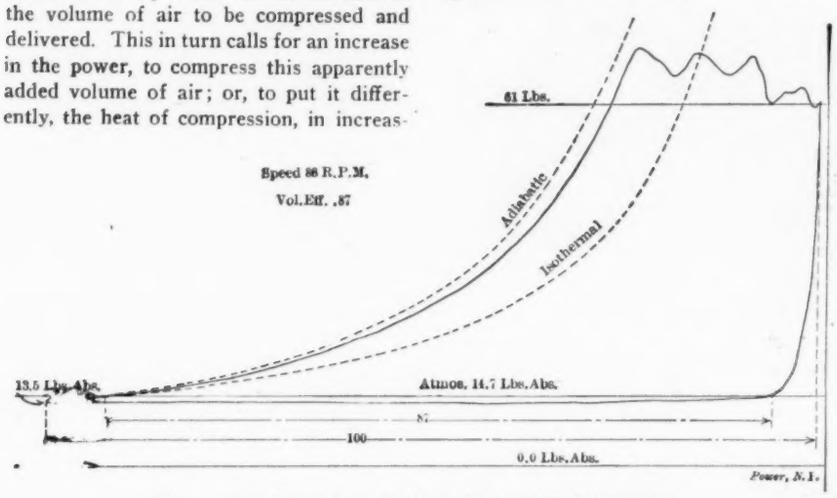


FIG. 1. INDICATOR CARD FROM SINGLE-STAGE COMPRESSOR.

When air is compressed in a cylinder without the removal or escape of any of the heat produced, the compression is known as "adiabatic." When compression is carried on in such a way that heat is removed as fast as produced, the compression is "isothermal." In the first case the air delivered under pressure will be at the high terminal temperature corresponding to that pressure. In the second, the compressed air will have the same temperature at which it entered the cylinder. Adiabatic compression is the kind which all pneumatic engineers seek to avoid, while isothermal compression is the impossible ideal. The actual results secured in the best compressors are intermediate between these, but nearer to the adiabatic.

Other things being equal, the economy of an air compressor depends on the proportion of the heat of compression which is removed as developed. Compressor efficiency, therefore, may be said to depend upon the effectiveness of the cooling devices adopted, provided what is gained here is not elsewhere wasted in whole or part. After long experience, bitter alike to makers and users, modern practice in compressor design recognizes only two practical methods of removing the heat of compression; jacket cooling and intercooling. These will be considered in order.

Jacket Cooling.—A brief consideration of the conditions will show that jacketed barrel cooling alone can be only a partial and very unsatisfactory solution of the problem of removing the heat developed by compression. With the piston at the beginning of its stroke, the maximum cold cylinder surface is exposed and the cylinder is filled with air at its lowest pressure and temperature. As the piston advances, pressure and temperature increase, while the effective area of cooling surface diminishes; and when the maximum pressure and temperature are attained near the end of the stroke, practically none of the cylinder wall is exposed except on the intake side of the piston; if the head is jacketed, it alone exerts any cooling influence. Furthermore, throughout the stroke only the outside layer of the air can be in contact with the cold surface and, air being a poor conductor of heat, none of the heat from the interior of the air volume is dissipated in the cooling water.

Cylinder jacketing is advisable and even essential for keeping the metal of the working parts at a low temperature, preventing the caking of lubricant upon the cylinder walls, and other evils of a hot machine. But it cannot of itself be considered as an adequate solution of the problem of cooling during compression. However, in constructions involving the use of a piston inlet tube and valve, not only the barrels, but the heads and discharge valves are chilled; and the piston and tube themselves are kept relatively cold. The air enters through a cold passage, is in contact on all sides with cold metal, and the maximum effects obtainable from jacketing alone are secured.

Intercooling.—If, at each of several points in the stroke of the piston should be stopped for a moment and the air, already partially compressed and heated, be withdrawn long enough to be cooled by some external means to its initial temperature and then returned to the cylinder to be further compressed, it is evident that a fairly uniform temperature could be maintained in the air volume throughout the range of pressures from initial to terminal. The result would be in effect nearly that of isothermal compression. Evidently mechanical considerations forbid in practice such repeated starting and stopping of the piston; but the same results may be secured by carrying on the process of compression in several cylin-

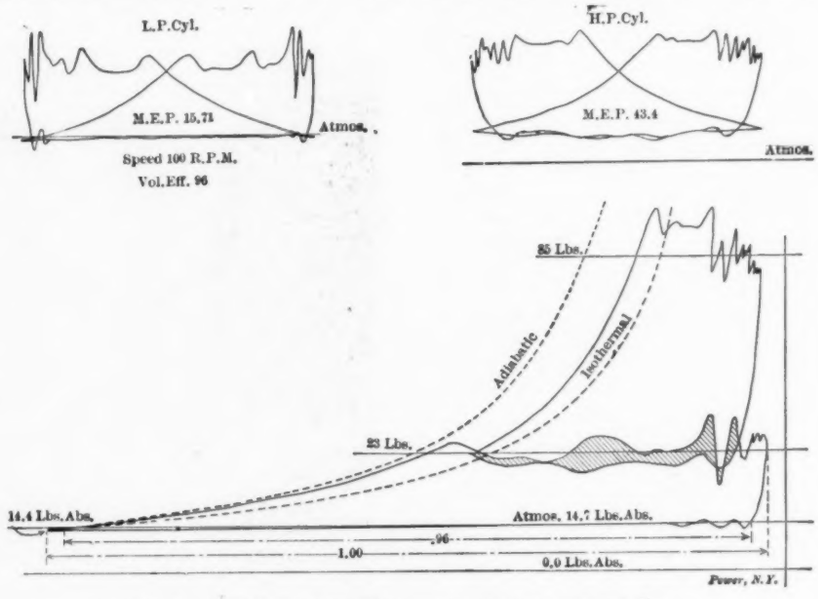


FIG. 2. INDICATOR CARD FROM TWO-STAGE COMPRESSOR 6-A.

ders, in the first of which a certain low pressure is reached and the air at this pressure discharged through a cooling device to a second cylinder; there it is compressed to a still higher pressure and is discharged through another cooler to a third cylinder for further compression; and so on, until the required terminal pressure is secured. Such a process, developed to a practical working basis, is the method of compression in multi-stage cylinders which has become practically standard in air-compressor work for the higher pressues.

Multi-Stage Compression.—Theoretically, there is a gain in compound compression, whatever the pressure. But with low pressures the saving is so small as to be offset by the greater expense and complication involved in several cylinders and the losses unavoidable in the operation of added parts. After extended experience, makers of air compressors have fixed upon 70 pounds gage pressure as the maximum terminal pressure which can be most economically obtained in a single cylinder; and for pressures from 75 pounds up, they have adopted compound compression in two, three and four stages, the number of stages increasing with the pressure. At high altitudes, however, with large volumes and expensive fuel, this dividing line may come at a lower pressure. It is elastic and depends somewhat on the conditions.

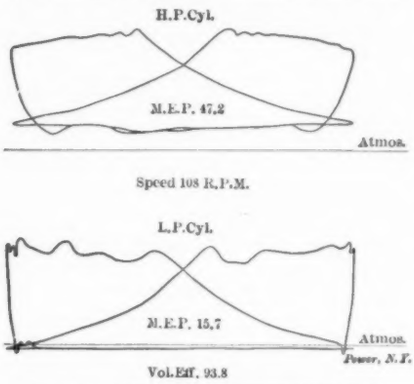


FIG. 3. CARDS FROM COMPRESSOR 9-A.

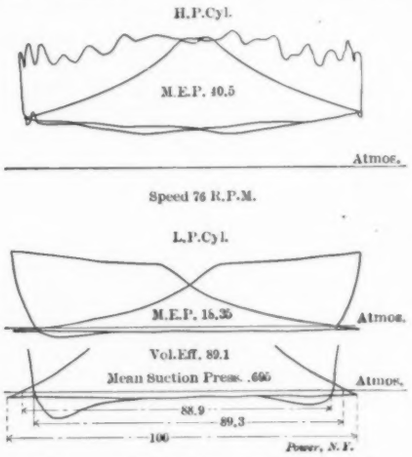


FIG. 4. CARDS FROM COMPRESSOR I-B.

In a compound air compressor, correctly designed, the cylinder ratios are such that the final temperature and total mean effective pressure are respectively the same in all cylinders, and all pistons are, therefore, equally loaded. The air compressed in the first cylinder to a pressure determined by the cylinder ratios is discharged through the outlet valves to an intercooler, where it is split up into thin streams passing over cold surfaces. The best practice provides a nest of tubes through which cold water circulates, and over and between which the stream of air passes, complete breaking-up and subdivision of the stream being secured by baffle plates and the tubes themselves. A properly designed intercooler having sufficient cooling area for the volume of air may reduce the temperature of the air compressed in the first cylinder to at least outgoing water temperature. From the intercooler this air, entering the second cylinder cold, is compressed to a higher pressure and again reaches a temperature nearly the same as that attained in the first cylinder. In two-stage machines this air will be discharged directly to the receiver without further cooling, unless conditions are such as to render advisable the use of an aftercooler. In three-stage machines the second cylinder is known as the intermediate, from which the air passes to the second intercooler to undergo a second reduction of temperature, and thence enter the third cylinder for final compression to required pressure.

It is evident that multi-stage compression is in effect identical with the theoretical process suggested above, in which the compressing piston was stopped and the air cooled at intervals during the stroke. The maximum cooling effect, and therefore saving, is secured by making the intercoolers of ample proportions and providing for the splitting up of the air stream into thin sheets exposed to cooling action.

The discussion thus far has dealt with the theory of compound air compression, the conditions encountered, and the means adopted in the best practice for meeting these conditions. General statements of the gains secured by compounding have been made. It remains to discuss in detail some of the more important and specific advantages arising from stage compression.

Reduced Power.—The accompanying table (1) gives the theoretical percentage of work lost in the heat of compression in one, two and four stages, at various pressures. In these figures no account is taken of jacket cooling, for the reasons already stated; nor is any allowance made for certain inevitable mechanical losses.

Taking a specific example, the saving by compounding strikingly appears. Assume that compressed air is to be delivered at a pressure of 100 pounds, and a rate equivalent to 100 final effective horse-power. Referring to the table, in the second column the theoretical percentage of lost work in one-stage compression is given at 38 per cent.; but, because there is bound to be some radiation of heat, this value will not be found in practice and 30 per cent. may be assumed as a good practical value for the loss under average conditions. On this basis it is found, in the present case, that to deliver 100 horse-power in compressed air at 100 pounds pressure by one-stage compression, the compressor will require 130 indicated horse-power, ignoring mechanical losses. Looking now at column 4 of the table, the percentage of loss in two-stage compression at this pressure is found to be 17.1 per cent., which is very close to the value which will be found in practice. Applying this value, it is evident that to deliver the equivalent of 100 effective horse-power in air at 100 pounds pressure by two-stage compression, about 117 indicated horse-power will be required. In this case, as between single and two-stage compression, we have a direct saving in favor of the latter of 13 indicated horse-power or 10 per cent. Considering the compression of the same volume to the same pressure in four stages, the percentage of loss is seen to be 8 per cent. from column 6, implying an applied power of 108 indicated horse-power. In this case the saving, as compared to single-stage compression, is 24 horse-power, or 18½ per cent. From these gains something must be allowed for the friction of extra me-

TABLE I. THEORETICAL LOSS IN COMPRESSING.

Gage Pressures.	One Stage.		Two Stage.		Four Stage.	
	Percentage of Work lost in terms of Isothermal Compression.	Percentage of work lost in terms of Adiabatic Compression.	Percentage of work lost in terms of Isothermal Compression.	Percentage of work lost in terms of Adiabatic Compression.	Percentage of work lost in terms of Isothermal Compression.	Percentage of work lost in terms of Adiabatic Compression.
60.....	30.	23.	13.38	11.8	4.65	4.45
80.....	34.	25.26	15.12	13.12	5.04	4.80
100.....	38.	27.58	17.10	14.62	8.00	7.41
200.....	52.35	34.40	23.20	18.88	9.01	8.27
400.....	68.60	40.75	29.70	22.90	12.40	11.04
600.....	83.75	44.60	32.65	24.60	15.06	13.10
800.....	90.	47.40	35.80	26.33	16.74	14.32
1000.....	96.80	49.20	39.00	28.10	16.90	14.45
1200.....	106.15	51.60	40.00	28.60	17.45	14.85
1400.....	108.	52.	41.60	29.4	17.70	15.00
1600.....	110.	53.3	42.90	30.0	18.40	15.54
1800.....	116.80	54.	44.40	30.6	19.12	16.05
2000.....	121.70	54.8	44.60	30.8	20.00	16.65

chanical parts and of the air through additional sets of ports, valves, coolers, etc. More especially is this true when the machine belongs to that class of machines termed "compound" by courtesy, attractive in price through frugal designing, in

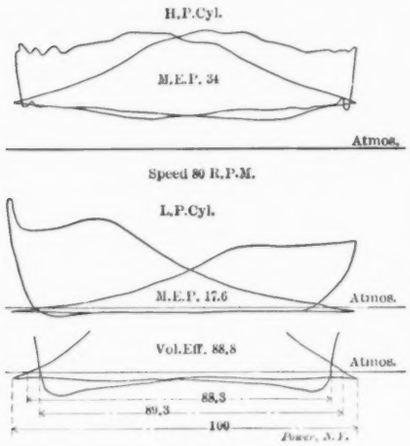


FIG. 5.

which small coolers, insufficient valve area, the use of a hot discharge port for the air intake, small ports, etc., are all antagonistic to economy.

Authentic and repeated tests show that such machines may actually require 10 to 15 per cent. more power per cubic foot of air really delivered than some well designed simple single-cylinder types. No more cylinders are required for the compound than for the simple machine, in duplex constructions. Yet here, too, the economy expected is only realized from high-class designs, generously proportioned, and fitted with large coolers and the other essential refinements of good practice.

Reduced Strains.—When compression is carried on in a single cylinder, the difference between the pressures at the beginning and at the end of the stroke is the total difference between initial and terminal pressures, entailing a great variation in strains on the driving mechanism and the structure of the machine. The greatest strains come near the end of the stroke and are almost instantly relieved when the inlet valves open. Thus the terminal strain on a 20-inch cylinder having 314 square inches area, at 100 pounds pressure will be 31,400 pounds, or nearly 16 tons. At 100 revolutions this strain is repeated 200 times per minute and demands a very rugged construction. This is a condition not conducive to easy operation in any but the most massively proportioned compressors.

In compound compression, on the other hand, the difference between initial and terminal pressures in each cylinder is but a fraction of the total range of pressure. The pressures, furthermore, are partially balanced in the several cylinders. The working strains on valves and other parts are consequently greatly diminished, resulting in a greatly reduced wear and liability to breakage, and securing free lubrication and a noticeable improvement in the way of smooth, easy operation of the machine. These are all facts which contribute to continuous and satisfactory service, with the least possible adjustment and attention. As a matter of fact, compounding the air cylinders transfers so much of the load from the later to the earlier part of the stroke that the maximum terminal strain on bearings is reduced fully 45 per cent. over that in single-stage compression; in the above case, the reduction would be from 3,140 "ton-minutes" to 1,727—obviously a much easier proposition mechanically. Misled by this point, it has been common to reduce the weight and size of bearings accordingly—a mistake which will be evident when it is remembered that the stoppage of circulating water in the cooler at once raises the load on the low-pressure piston; while a broken or damaged outlet valve on the high-pressure cylinder may

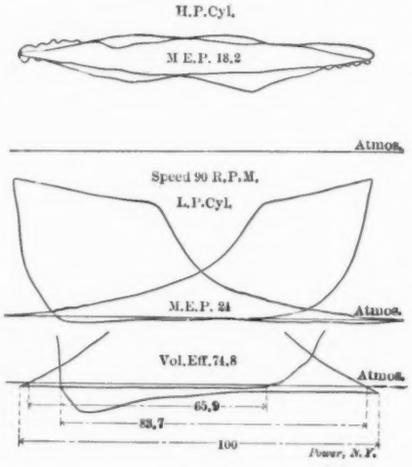


FIG. 6.

at any moment throw the same load on all parts as in a single-cylinder machine.

Improved Steam Economy.—The more equable distribution of the load throughout the stroke in compound compression, just noted, also aids in securing a higher economy in steam consumption at the lower end of a "straight-line" machine; for it makes possible an earlier cut-off in the steam cylinders and a consequently greater steam expansion with its attendant saving, late cut-offs not being so necessary to prevent "dead-centering." Multi-stage compression with effective intercoolers between stages also permits a higher piston speed, in itself a factor in steam economy in reducing the leakages and condensation in the steam end.

Higher Volumetric Efficiency.—The air remaining in the clearance space at the end of the stroke must be expanded on the return stroke to atmospheric pressure before free air can enter through the inlet valves. Evidently the higher the pressure in the clearance space, the greater will be the expanded volume, and the lower will be the intake efficiency of the cylinder. In single-stage compression the clearance pressure is the working pressure; in compound compression the clearance pressure in each cylinder is the terminal pressure in that cylinder. But this terminal pressure in the intake cylinder is low—usually not over 25 pounds per square inch when the final working pressure is 100 pounds. The volumetric efficiency of compound-compression cylinders is higher for this reason, the clearance in the low-pressure cylinder only being in question.

Another element conducive to high volumetric efficiency in compound compression is the fact that the terminal pressures, and consequently the terminal temperatures, are lower than in single-stage cylinders. The cylinder walls and, more particularly, the heads, together with the valves and ports which may be in them, are therefore kept much cooler and the entering air is not heated so much by contact with these parts. A third element entering into the question of efficiency is the reduced leakage through valves and past piston and rods, with the incidental loss of power. It is evident that the higher the pressure the greater the liability to leakage; and the small range of pressures in multi-stage cylinders reduces this loss.

Dryer Air.—One of the greatest difficulties hitherto encountered in air-power transmission has been the freezing of the moisture in the air, in the pipe line or at the exhaust ports of the air motors. One of the great advantages of the sub-division of compression into several stages lies in the opportunity it affords for cooling the compressed air at intermediate stages to a temperature at which its moisture will be precipitated. Of course practically all of this condensation occurs in the inter- and aftercoolers; and herein appears a necessity for a design which

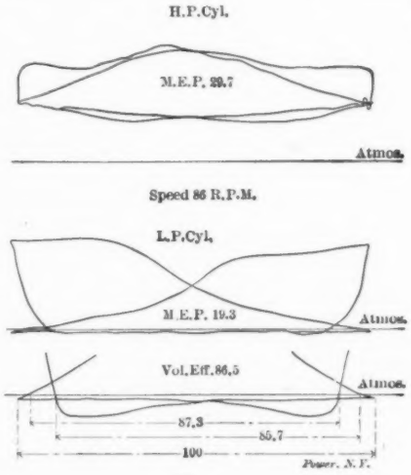


FIG. 7.

will pass the air at low velocity with full opportunity for cooling on the water tubes. The moisture in suspension is withdrawn through the drain pipe. It is needless to say that unless some provision is made for arresting and withdrawing the con-

densed water from the intercooler, the value of the latter as an air-dryer is lost; for the moisture is carried over into the compression cylinders, producing cutting and leakage and working out into the pipe line. Aftercoolers are in some instances as important as intercoolers in removing moisture.

Better Lubrication.—If air be compressed in a single cylinder from atmospheric pressure and temperature of 60 degrees Fahr. to a final pressure of 100 pounds, the maximum temperature attained may be 484 degrees Fahr. This temperature is manifestly destructive to common lubricants, and oils of ordinary quality are burned into a solid, gritty, coke-like or gummy substance, which gives the very reverse of proper lubrication. This deposit, moreover, collecting in ports and valves may so obstruct and clog them as to cause leakage and throw an added load on the compressor.

If, however, this same volume of air be compressed in the first cylinder to a pressure of 25 pounds, the highest temperature which can be reached is only 233 degrees—a heat which will not destroy the lubricating qualities of good oils such as should be used in compressor work. This air, passing through the intercooler, will be brought back to about the original temperature of 60 degrees and compressed, in a two-stage compressor, from 25 to 100 pounds in the second cylinder. Here the maximum temperature attained will be but little, if any, in excess of that in the first cylinder, since the heat of compression is a function of the number of compressions, and is almost wholly independent of the initial pressure. In multi-stage compressors, therefore, the conditions of temperature are evidently most conducive to thorough lubrication of piston and valves, tending toward durability of working parts, with long life and high efficiency of the machine.

The advantages of compound air compression have gradually forced themselves upon the attention of pneumatic engineers. Not many years ago, when pressures were lower, the majority of compressors were single-stage machines. But with the growing tendency toward higher pressures, and an understanding of needed economies, compound compressors came into greater prominence; and of late much the larger percentage of installations have been machines of this style.

But it will not do to reason that any compound compressor is necessarily more economical than a high-class simple machine, for such is not the case. On the contrary, only compounds of the highest class are advantageous from an economical standpoint. The gains depend not simply upon stage compression and effective cooling, but also upon correct design throughout the machine and a consistent attention to every detail. Every condition which may possibly affect the air from intake to discharge must be properly considered and provided for. Some of these defects which may offset compression economy have been noted at intervals throughout the preceding discussion. But their importance merits a repetition of them here: A weak structure and insufficient bearings (based on a mistaken idea of reduced strains),

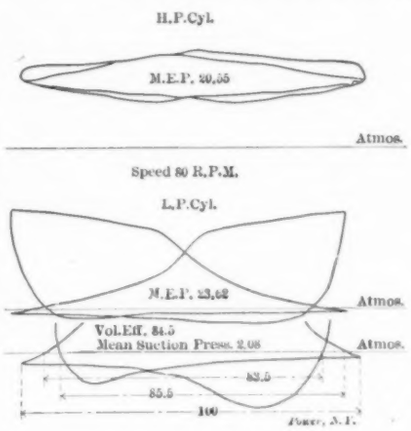


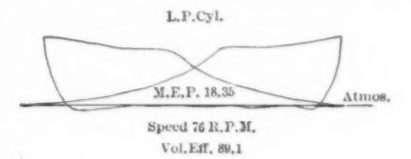
FIG. 8.

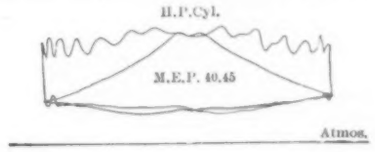
with no provision for unexpected contingencies, resulting in excessive friction losses; multiplicity of wearing parts, absorbing a large portion of the power theoretically saved; heated and restricted air passages, inefficient valves, neglect of proper jacket and head cooling; small and ineffective intercoolers; poor workmanship, resulting in leakage losses.

Not only may the enumerated defects largely offset the saving by compression in stages, but it is a fact that compounds now on the market may require more power per cubic foot of air compressed than well-designed, high-class, simple compressors of equivalent capacity. This latter statement embodies so great an apparent engineering heresy as to demand a strong substantiation in fact. For this reason the following test is reported. For obvious reasons the names of the makers of the compressors in question are withheld. It may be stated here, however, that the machines are standard types of American builders of established reputation at home and abroad; the two manufacturers have been distinguished by the terms "Maker A" and "Maker B." The object of the tests was primarily to ascertain the comparative economies of compound compressors of average type and simple machines of the highest grade, more especially under practical conditions of continuous use.

To make the tests fair and representative, compressors in actual service were selected, and those tested have been in operation for from two to fourteen years under average working conditions and average attendance. But the results showed up the compounds in such an unfavorable light, that it was determined to continue the investigation, to include compounds of the same grade of workmanship and the same make as the simple machine tested. However, no old compressors of this type were available, so new machines were tested at the builder's shops, just before shipment. The conditions in all tests were made as nearly identical as possible and the results show in a striking manner the effect of correct design and workmanship on compressor efficiency.

The thing which appeals to the buyer is the economy of the machine he purchases —the saving he will secure by its use. In an air compressor, two distinct efficiencies are to be considered: the volumetric efficiency, or ratio of actual to theoretical air capacity; and the compression efficiency, or ratio of actual power required to the theoretical. To facilitate comparison in the present case, the several values from





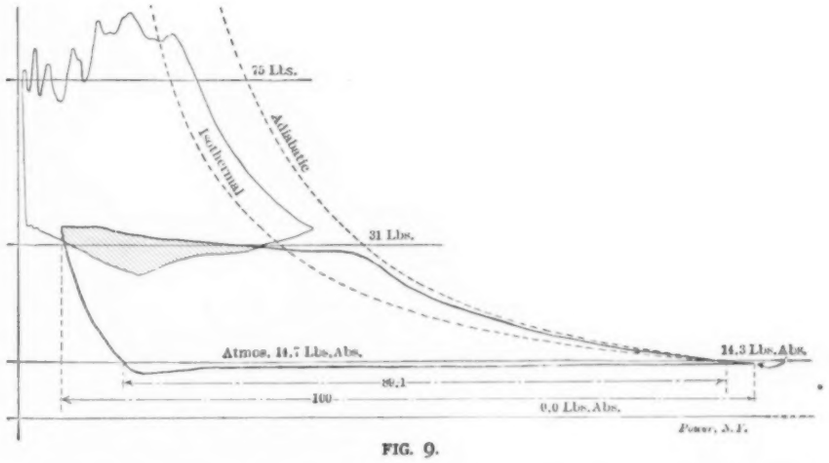


FIG. 9.

the preceding report are here grouped and averaged:

VOLUMETRIC EFFICIENCIES.

"Maker A," two-stage—96, 96.4, 92.6 and 93.8 per cent.; average, 94.7.

"Maker A," single-stage—87, 89.1, 87.4, 91 and 86.5 per cent.; average, 88.2.

"Maker B," two-stage—89.1, 88.8, 74.8, 86.5 and 84.6 per cent.; average, 84.76.

3.44 per cent. in single-stage machines.

COMPRESSION EFFICIENCIES.

"Maker A," two-stage—91.25, 92, 92 and 93 per cent.; average, 92.06.

"Maker A," single-stage—82, 82, 82.1, 84.5 and 84.3 per cent.; average, 82.98.

"Maker B," two-stage—80.9, 81.8, 70.5, 75.5 and 67 per cent.; average, 75.14.

The high-grade compounds waste but

TABLE 2. SINGLE-STAGE AIR COMPRESSORS—"MAKER A."

Machine No.	1A.	2A.	3A.	4A.	5A.
Diameter air cylinder, inches	26	26	26	26	26
Diameter steam cylinder, inches	24	24	24	24	24
Stroke, inches	30	30	30	30	30
Speed, R. P. M.	88	80	84	60	80
Mean net area—air cylinder	519.8	519.8	519.8	519.8	519.8
Air cylinder displacement	1,590	1,445	1,518	1,080	1,445
Free air shown by L. P. card	1,383	1,285	1,324	973	1,250
Volumetric efficiency, %	87	89.1	87.4	91	86.5
Receiver pressure	61	60	61	92.5	95
Horse-power, air cylinder	201.5	185	192	171	223.5
Air horse-power per 100 cu. ft. free air	14.51	14.4	14.5	17.6	17.86
Computed horse-power per 100 cu. ft. adiabatic comp.	13.5	13.35	13.5	17.3	17.52
Efficiency compared with perfect one-stage comp., %	93	92.8	93.2	98.4	98.2
Computed horse-power per 100 cu. ft. perfect two-stage comp.	11.9	11.8	11.9	14.83	15.05
Efficiency compared with perfect two-stage comp., %	82	82	82.1	84.5	84.3
Indicator Card	Fig. 1	Fig. 1			

It here appears that the high-grade two-stage compressors of "Maker A" suffer an average loss in capacity of only 5.3 per cent. of the theoretical; the high-grade single-stage machines lose on the average only 11.8 per cent. of the theoretical capacity; 7.94 per cent. of the theoretical power required; the single-stage machines of the same grade lose 17.02 per cent.; while the ordinary two-stage compressors of "Maker B" waste 24.86 per cent. of the power applied to them.

TABLE 3. TWO-STAGE AIR COMPRESSORS—"MAKER A."

Machine No.	6A.	7A.	8A.	9A.
Diameter L. P. air cylinder, inches	20	20	15	26
Diameter H. P. air cylinder, inches	13	13	10	16
Diameter steam cylinder, inches	18	18	14	24
Stroke, inches	18	18	14	24
Speed, R. P. M.	100	80	155	108
Mean net area L. P. air cylinder	308	308	171.33	515
Mean net area H. P. air cylinder	132.46	132.46	78.54	198.45
L. P. cylinder displacement	642	513	430	1.545
Free air shown by L. P. card	616	495	398	1,448
Volumetric efficiency, %	96	96.4	92.6	93.8
Intercooler pressure	23	23	22	25
Receiver pressure	85	82	90	90
Horse-power L. P. air cylinder	44	35	28	106
Horse-power H. P. air cylinder	52.25	40.1	35.8	122.8
Total air horse-power	96.25	75.1	63.8	228.8
Air horse-power per 100 cu. ft. free air	15.6	15.15	16	15.82
Computed horse-power per 100 cu. ft. two-stage comp.	14.22	13.92	14.71	14.7
Efficiency compared with perfect two-stage comp., %	91.25	92	92	93
Indicator Cards	Fig. 2			Fig. 3

while the ordinary two-stage compressors of "Maker B" lose an average of 15.24 per cent. of their theoretical air displacement. High-grade workmanship and correct design, therefore, effect in these instances an average saving in air capacity of 9.94 per cent. in the two-stage types and

The striking feature of this is the enormous waste in the compounds of "Maker B," due to defects such as have been briefly suggested. These losses have more than offset the advantages of compounding. Even the single-stage machines of "Maker A" show an average superiority

TABLE 4. TWO-STAGE AIR COMPRESSORS—"MAKER B."

Machine No.	1B.	2B.	3B.	4B.	5B.
Diameter L. P. air cylinder, inches	28	28	28	28	26
Diameter H. P. air cylinder, inches	17½	17½	17½	17½	17½
Diameter steam cylinder, inches	28	28	28	28	24
Stroke, inches	30	30	30	30	30
Speed, R. P. M.	76	80	90	86	80
Mean net area L. P. air cylinder	611.9	611.9	611.9	611.9	527.4
Mean net area H. P. air cylinder	231.9	231.9	231.9	231.9	231.2
L. P. cylinder displacement	1,618	1,700	1,915	1,830	1,465
Free air shown by L. P. card	1,440	1,510	1,430	1,580	1,240
Volumetric efficiency, %	89.1	88.8	74.8	86.5	84.6
Intercooler pressure	31	28	50	33	34
Receiver pressure	75	64	68	58	55
Horse-power L. P. air cylinder	129	130.8	200	154	151
Horse-power H. P. air cylinder	108	95.4	57.5	89.5	57.5
Total air horse-power	237	226.2	257.5	243.5	208.5
Air horse-power per 100 cu. ft. free air	16.45	15	18	15.4	16.82
Computed horse-power per 100 cu. ft. two-stage comp.	13.3	12.28	12.7	11.62	11.27
Efficiency compared with perfect two-stage comp., %	80.9	81.8	70.5	75.5	67
Indicator Cards	Fig. 4 Fig. 9	Fig. 5	Fig. 6	Fig. 7	Fig. 8

of 7.84 per cent. over these defective compounds, while comparison of the two two-stage types shows an average advantage of 16.92 per cent. in favor of "Maker A's" high-class machines, correctly designed and properly proportioned for the duty.

Compression efficiencies for "Maker A's" single-stage machines, in the last line of the table, are referred to perfect two-stage compression, simply for ready comparison with the compound machines. It is to be noted that the efficiency of these compressors compared to perfect one-stage compression is also given, as follows: 93, 92.8, 93.2, 98.4 and 98.2 per cent.; average, 95.12. This means that on the average these machines depart less than 5 per cent. from theoretically perfect performance in their type. Such efficiencies indicate a remarkable refinement in design and workmanship and exemplify the importance of the care bestowed upon what are usually considered minor details.

The term "compound" or "two-stage" as applied to air compressors should properly stand for superior economy. The buyer of a compound rightfully expects a saving by its use. The foregoing tests, taken without prejudice from average machines in ordinary practice, indicate how even reputable builders, acting no doubt in all good faith, may furnish a compressor which may prove a veritable "gold brick" in the hands of the trusting purchaser. Poor practice may prove the undoing of the best theory. That compressor only is a commercial and economical success which embodies a sound theory in a mechanical structure correctly designed, built by skilled and careful workmen, and so simple as to be readily understood, handled and maintained by mechanics of average intelligence.

The derivation of the name of the metal antimony appears to be involved in considerable obscurity, but we must admit that our credulity is severely taxed by the following explanation which we find in the *Brass World*: "Antimony derived its name in a peculiar manner. When first discovered in the fifteenth century, it was fed to swine by monks in order to test its effect. The swine seemed to thrive upon the metal, and it was then deemed safe to try it upon the fellow monks. The effect was different than upon the swine, for the monks died. The metal was then given the name of antimony (anti-monk)."

The Otis Elevator Company of New York is sending its friends a book known as "King's Views of New York", which is a remarkable and very interesting publication, consisting mainly of half-tones, showing the striking features of the city of New York, many of which consist of its tall buildings, which have been made possible by the use of the modern elevator.

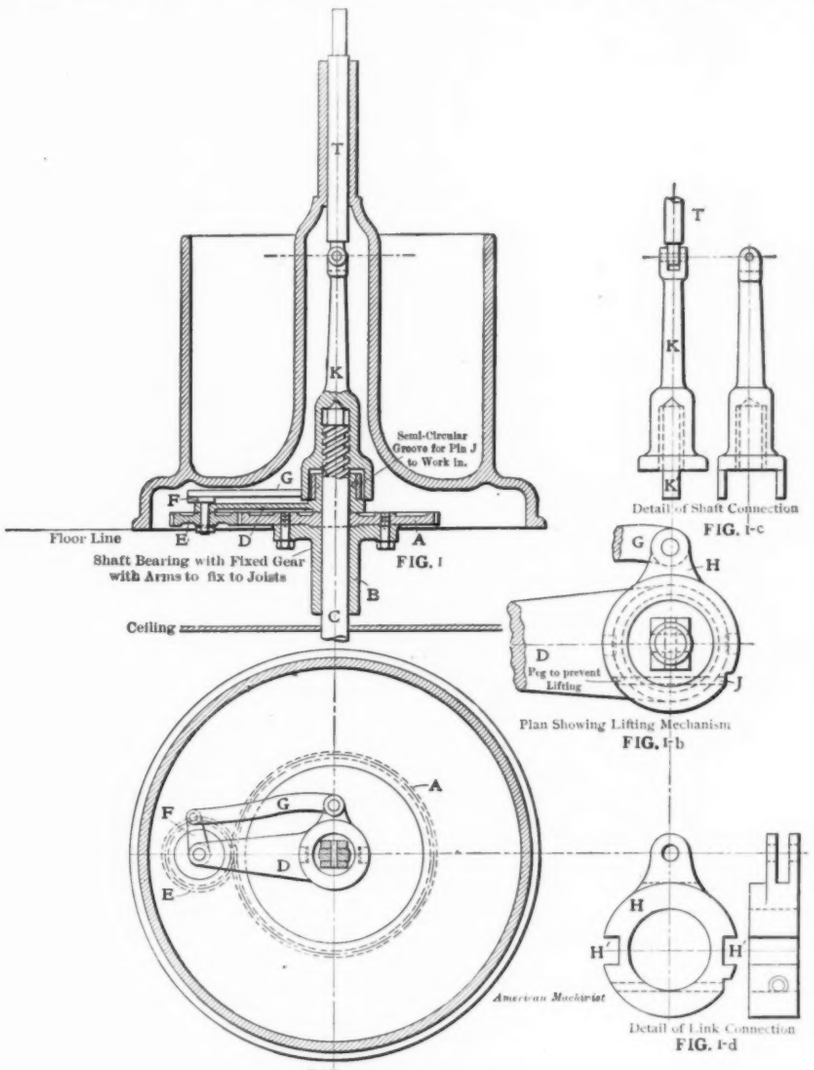
Studies in Inventive Problems—XIV.

Proposed by Leicester Allen and Solved by Various Readers.

I shall, at the end of this article, present Problem IX.

I am in receipt of an additional alleged solution of Problem III, together with a criticism on solutions of the same, by Mr. W. F. Slade, of Foleshill, Coventry, England, who, as I am informed, is the originator of a number of meritorious tools for various purposes. He makes general criticism in substance, that the solutions proposed for Problem III are, for the most part, not mechanical in construction, and, in use, would work only for a short time. I think this criticism as applied to some solutions is just, as may have been inferred from my own remarks in presenting the solutions; but it will be remembered that the conditions named at the beginning of this series, do not justify me in rejecting a real solution on the ground of inefficient design. If a solution will produce the movements required in the statement of any problem, I am bound to accept it. And I have presented some that did not fully meet the requirements, simply to emphasize and exemplify points likely to be overlooked by comparatively inexperienced designers, and I believe this course has conduced to the educational purpose of the series, which is directed to the development of the inventive capacity, and only collaterally to the art of designing.

Mr. Slade also sends a rough sketch and very brief description of a device (which, I believe, is quite generally known) for drilling a square hole which will move a sliding block in an approximately square path, but which would not, I think, prevent more or less tilting of the block, when resistance is unequally applied thereto. Moreover, I cannot see how this movement could be applied to the table which forms an element of the problem. The problem is not merely to move the geometrical center of a square block in a square path, but to move it under the stipulated restrictions and limitations.



SOLUTION NO. II TO PROBLEM V.

I am also in receipt of a solution of Problem V, which came to hand shortly after the last article of this series was placed in the printer's hands. The idea of obtaining the required variable rotary motion of the spindle by a fixed gear, around which travels another spur wheel, intermeshing with the fixed one, is worked out in this solution, as in my own solution presented in the last number of this series; the method of securing the vertical reciprocation is different, but it will be seen that both the rotary and reciprocating motions of the spindle are derived from the crank-pin actuated in precisely the same curve as that in my solution. The analogy between the two solutions is very close. A very neat and complete sketch of the mechanism is supplied with the description which follows:

PROBLEM V, SOLUTION NO. II, FIGS. 1, 1*a*, 1*b*, 1*c* AND 1*d*. J. COOK, BELGRAVE, LEICESTER, ENGLAND.

"Fig. 1 is a sectional elevation. Fig. 1*a* is a partly sectional plan, the section being made through the base of the receptacle for the sifted material. The remaining figures are self-explanatory, Fig. 1*b* being an enlarged portion of the plan, Fig. 1*c* a detail of connection *K*, and Fig. 1*d* a detail of lever *H*.

"The spur wheel *A* is fixed to the bearing *B*, which supports the vertical rotating shaft *C*. Upon the shaft *C* is mounted an arm *D*, which carries a pinion *E* mounted on a crank-shaft *F*. The crank-pin connects through a link *G* to a short lever *H* mounted on arm *D*, being free to turn horizontally and prevented from lifting by a pin *J*, the latter fitting into a semicircular groove turned in the hub of arm *D*. Upon shaft *C* is cut a square thread of the proper pitch to secure the stated vertical reciprocation of the spindle *T*, and upon this screw is mounted the internally screw-threaded connection *K*, attached to the spindle *T*. On the lower end of connection *K* are formed two projections *K'* which engage in jaws *H'*, formed on lever *H*. The operation is obvious. The rotation of pinion *E* generates the variable rotative velocity, while at the same time the partial rotation of the lower part of *K* to and fro, on the screw-threaded part of shaft *C*, secures the vertical reciprocation required in the enunciation of the problem."

I have no doubt that a satisfactory machine can be constructed on these lines, if the vertical reciprocation be limited to an amplitude consistent with a proper working pitch of screw thread. But it will be remembered that the lifting of the spindle, in accordance with the terms of the problem, must be effected while the spindle is making one-sixth of a turn. Hence, the screw action involves a pitch that will lift the full distance while the spindle is making one-sixth of a turn.

The lowering of the spindle will take place during the next succeeding one-sixth of a turn, thus completing the full reciprocation in one-third of a turn. It was stated in the problem that the amplitude of the vertical reciprocation must not be less than one-third the internal diameter of the vertical hollow column in the center of the receptacle for sifted material. Now if the reader considers the pitch of a screw required to secure this amplitude with one-sixth of a turn, I think it will be agreed that, in the available space, it would be difficult to so design this feature as to meet the requirement in a practical way.

PROBLEM V. SOLUTION NO. 12. C. W. PITMAN, PHILADELPHIA, PA.

In this solution the required movements are attained by use of elliptic gears for varying the rotative speed of the spindle and a cam for effecting the vertical reciprocation. In principle it is identical with solutions No. 3 and 4, and it is differentiated very little in details of construction from those solutions, for which reasons, though very neat sketches accompany the description, I do not reproduce them, economy of space being always imperative in the AMERICAN MACHINIST.

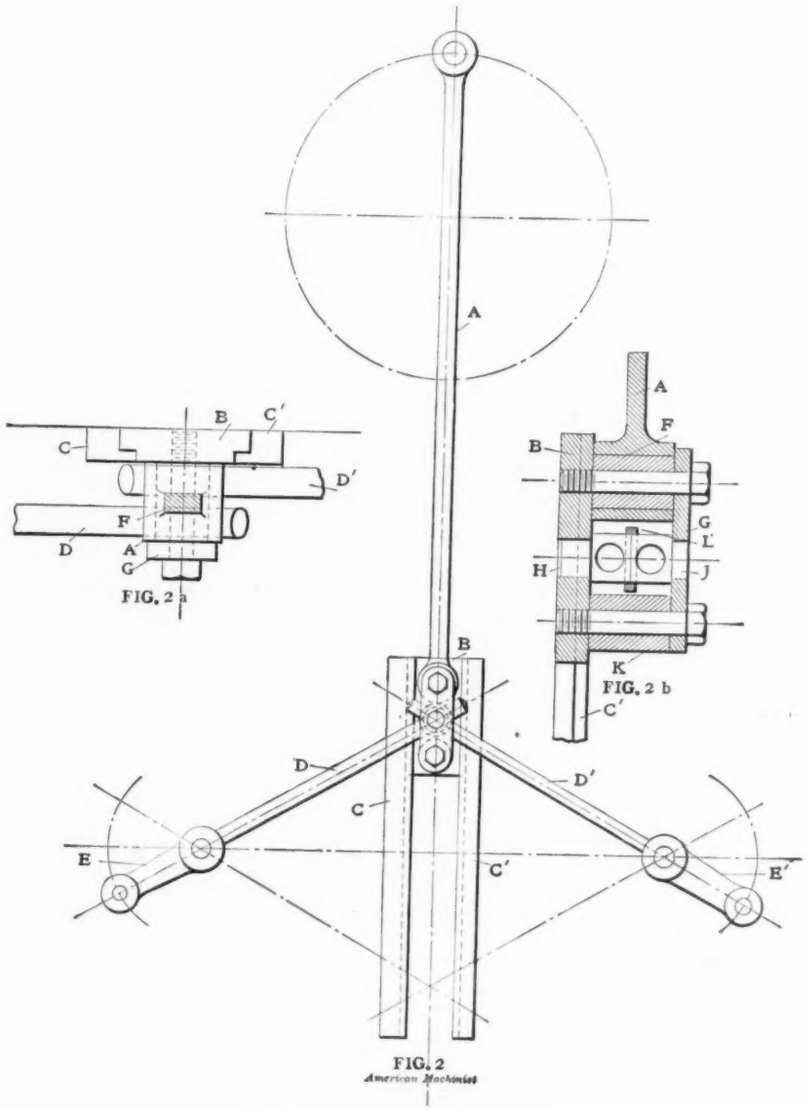
Only two attempts at the solution of Problem VI have come to hand. That this problem is capable of a simple and easy solution by any designer who understands something of the laws controlling the composition and resolution of forces, is shown by the following:

PROBLEM VI, SOLUTION NO. 1, FIGS. 2, 2a, 2b. HAROLD SMITH, BRADFORD, YORK, ENGLAND.

Mr. Smith describes the mechanism shown in the figures, of which Fig. 2 is an assembly drawing, while Figs. 2*a* and 2*b* are details:

"*A* is the pitman; *B* a sliding block; *C* and C^1 guides for *B*; *D* and D^1 (round) steel levers; *E* and E^1 resistance arms, *F* a fixed bush; *G* a plate; *H* and *J* swiveling bearings for *D* and D^1; *K* a distance piece similar to *F*, and *L* a loose ring. The general arrangement will be evident from Fig. 2*a* which is a plan of the arrangement as seen from crank. Fig. 2*b* is a section through the center line. The smooth round steel arms *D* and D^1 are fixed into the resistance arms, one on each side of the center. They work through the holes shown in *H* and *J*. The bushes *H* and *J* are free to oscillate in *B* and *G*. The ring *L* is a working fit over *H* and *J*, and between *D* and D^1 and is simply to give more rigidity to the arrangement. *F* and *K* are simply distance pieces to support *G*, but *F* also acts as a bush for pitman *A* to work on. The block *B* slides in guides *C*, *C'*. I suppose that the respective resistances to arms *E* and E^1 increase as they move away from the center line and that the power applied must increase in proportion. It is evident that the length of levers *D* and D^1, in use, increases as they move away from the center line and also that the pitman exerts most force when the crank is passing the dead centers."

Mr. Smith's solution satisfies all the requirements of the problem. Different solutions are within apparent possibilities. Mr. M. F. Bates, of Stockton, California, contributes a sketch and descripton of a construction which I do not think will accomplish the results demanded by the problem. I shall present his sketch because it affords an opportunity for discussion that will, I think, clear away some stumbling blocks to the full understanding of this problem and to others of analogous character likely to present themselves in mechanical construction.



SOLUTION NO. 1 TO PROBLEM XIII.

Mr. Bates' very neatly executed sketch is reproduced in Fig. 3, and his description follows:

"The levers *a a* are moved in unison through an arc of more than 30 degrees, by means of a crank and connecting rod *b*. The inner ends of the two levers are pivoted to sliding blocks *c* which work in a quadrant forming part of the connecting-rod. The lower end of the connecting-rod is guided by a crosshead running in guides, as shown.

That this arrangement of parts will fail to distribute force delivered from the crank-pin proportionately to the resistances overcome by the resistance arms, will be apparent, I think, from the following analysis, with reference to the diagram, Fig. 4:

If the distribution of the force is proportional to resistances applied respectively at *r* and r^3, this, being a general requirement, will be true when the resistance at *r* is equal to the resistance at r^3; and we will assume for purposes of argument that the resistances are equal. Also it will be evident, supposing friction to be *nil*, that the force applied at *C* can never exceed the sum of the forces required to be applied to points *c* and c^1, in order to overcome the sum of the resistances. The direction of application of that part of the force which actuates the lever $c^1 r^3$, is $C g^1$, the point of application being at c^1. Analogously the direction of that portion of the force applied to lever

$c\ r$ is the line $C\ B$ being, as shown by Mr. Bates' drawing (Fig. 3), a little to the left of c, the fulcrum being at f in the diagram. The lines of direction in the diagram accord with the position of the parts in Fig. 3. The lines of direction will, of course, change position successively at every point in the revolution of the crank-pin center; but the conditions of the problem must be fulfilled at every point successfully, exclusive of the point shown.

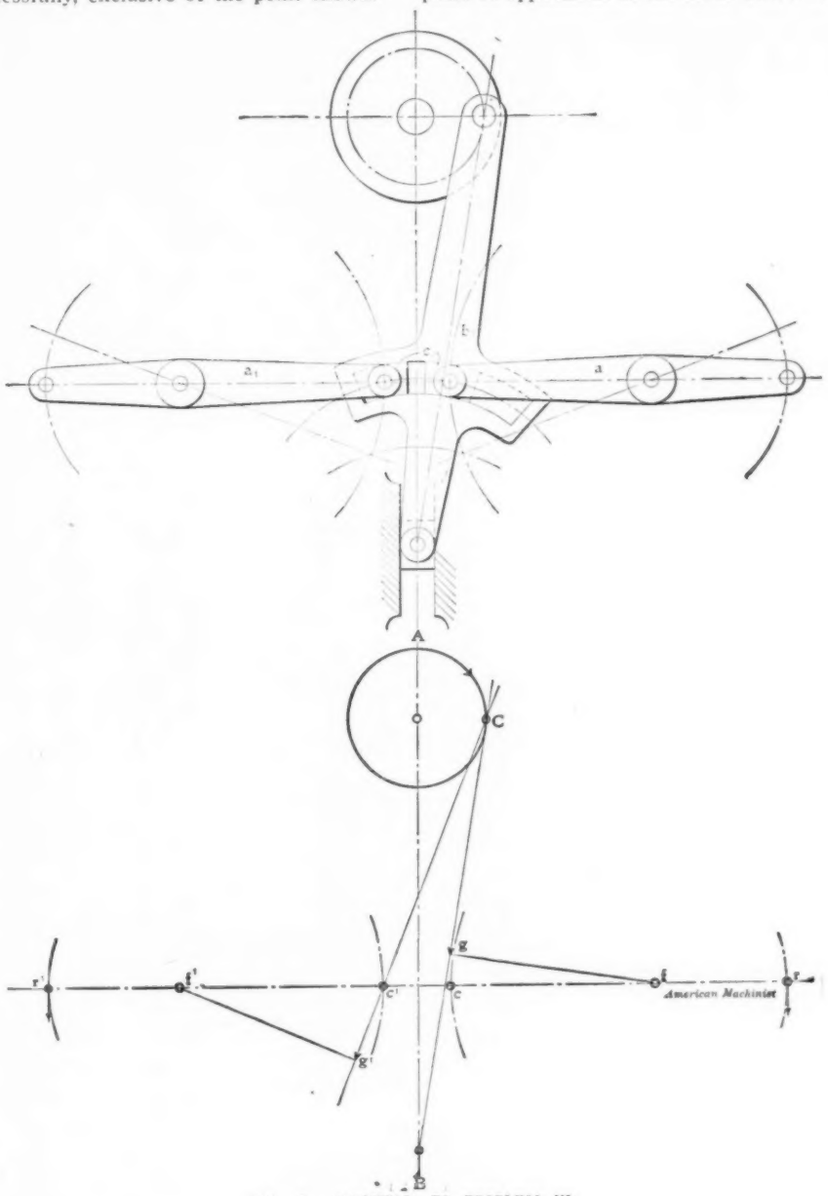


FIG. 3. SOLUTION TO PROBLEM VI.

FIG. 4. SKELETON DIAGRAM OF FIG. 3.

Extending line $C\ g^1$ and letting fall upon it the perpendicular $f^1\ g^1$, this line, multiplied by the force applied at c^1, represents geometrically the moment with respect to f^1 of that part of the force applied to moving lever $c^1\ r^1$. Similarly the line $f\ g$—perpendicular to $B\ C$—multiplied by force applied at c, represents the moment with respect to f of that portion of the force applied to move lever $c\ r$. To overcome equal resistances these moments should be equal. It will be readily perceived—$f^1\ g^1$ being less than $f\ g$—that they are not equal. It might also be proved that with equal resistances applied at r and r^1 the moments could never be equal, except when the force of the pitman is applied in a plane including the line $A\ B$ and also perpendicular to the plane in which the levers move. Mr. Smith in his solution fulfills this condition by using crosshead and guides, and making the point of application of the force delivered by C constantly coincident with the center of the crosshead pin.

I shall defer presenting my own solution of this problem, in the hope that other solutions may yet come to hand.

Next in order is Problem VII. The first solution of this problem was sent in by Mr. William Whaley, mechanical engineer, draftsman and designer, who introduces his solution as follows:

"It seems to me that this might well form the basis of a valuable machine, and should any of your readers be interested in this particular solution, I would be glad to correspond with them. The problem is a 'daisy' and, at first sight, seemed a hard one. Of course, as you will see, the definition of the curve forms the basis of my solution."

PROBLEM VII. SOLUTION NO. 1. EIGS. 5 AND 5a

WILLIAM WHALEY, NO. 603 EMPIRE BUILDING, KNOXVILLE, TENN.

This solution is a model one in form of presentation, both the drawing and description being respectively fine specimens of work, each of which is here presented exactly as received:

"In the drawings, Fig. 1 is a plan of my device, and Fig. 2 is a section. The problem is to guide the axis of a cutter in a spiral path, and to drive the cutter. *A* is the table of the machine, to which is secured the housing *B*. The revolving head *C* is composed of a lower and upper piece bolted together and having a space enclosed in which are placed the gears to drive the cutter spindle, independently of the motion of head *C*. Lower part of *C* has a slotted guide way for the sliding block *D* carrying cutter spindle. A stem projects from block *D* and at its further end is enlarged and threaded to fit a long nut or sleeve *E*, which is fitted into a bore in lower piece of *C* in line with slotted guide way. This sleeve *E* is held in its bore by a cap piece, bolted to *C* at a and has a stem projecting through cap. To this stem is fastened a bevel pinion *F*, which meshes with a bevel gear *G* secured to the housings. The upper part of *C* is turned down to form a journal, where it passes through housing, and has secured to its upper end a spur pinion *H*, which meshes with a segment of gear *I*, said gear being operated by a crank and pitman as shown. The sliding block *D* carries the cutter spindle, to which is secured a spur gear 2 which is connected through a swinging idler 3 to a gear 4 on sleeve on stud 5 in head *C*. On the upper end of this sleeve is fastened gear 6, which meshes directly with gear 7, on lower end of shaft 8, passing through *C*; said shaft 8 is driven by belting on pulley 9. The operation is as follows:—The cutter spindle *I* is driven at a constant speed independently of its position on head *C*, through pulley 9, shaft 8 and gears 7-6-4-3-2, the knuckle joint allowing free motion of the sliding block. The ratio of *H* to *I* is 1 to 3, hence when the pitman oscillates *I* through ⅓ revolution, *H*, and consequently *C*, will make one complete revolution. While making this revolution the pinion *F* traveling with *C* and meshing with stationary gear *G* will make with ratio shown, 18 revolutions; the sleeve *E* then makes 18 revolutions and forces the threaded stem of *D* to move outward; say if stem and *E* are threaded 1½ turns per inch the block D will move 12 inches outward in one revolution and, as will be seen, the velocity of block *D* from the center to circumference is exactly in time

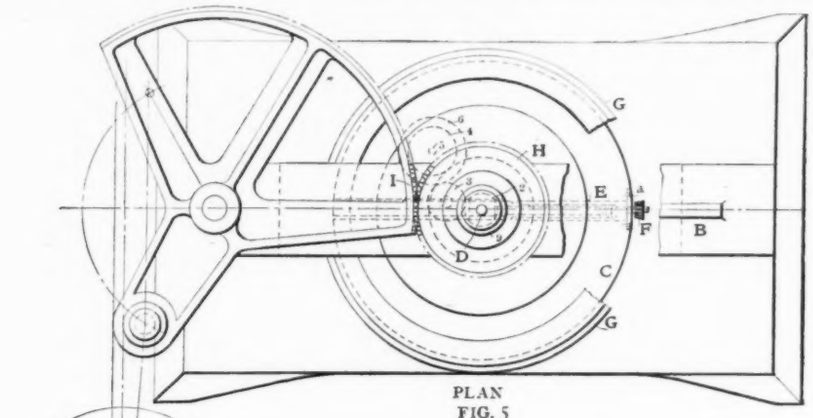
with and dependent on the angular velocity of *C*, and hence follows a perfect spiral path. This spiral could be easily changed in its proportions by substituting other proportions, threads and gearing to produce any number of different spirals on the same machine. Said gearing could be arranged as intermediate between *G* and *F* and used in a manner similar to change-gears of an engine lathe."

Without any disparagement of other fine solutions of this problem yet to be presented, I will express my opinion that it is not likely to be surpassed in mechanical construction, inventive ability, or form of presentation.

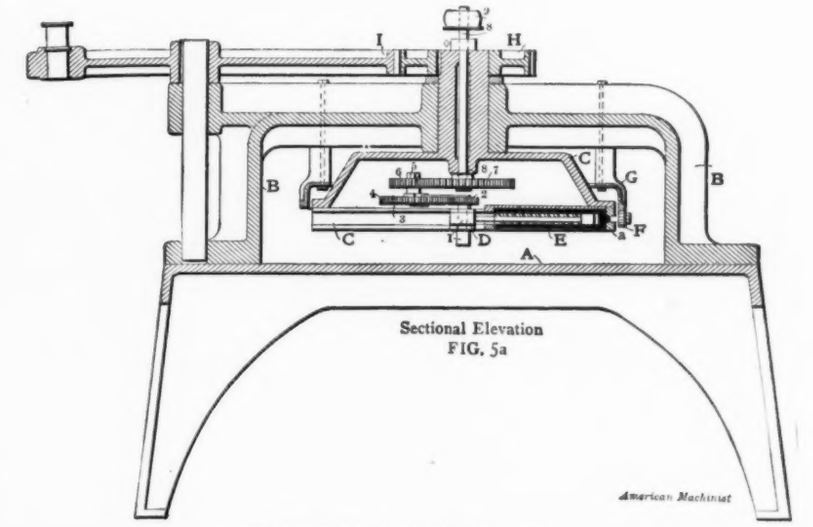
PROBLEM VII. SOLUTION NO. 2. FIGS. 6, 6a AND 6b. MR. JOHN GARGAN, UTICA, N. Y.

This is another well thought out and elaborate solution, arriving at the desired result, by mechanism, considerably differentiated from that of Mr. Whaley. It is very gratifying to receive solutions of this high grade. In presenting this solution Mr. Gargan remarks that the conditions of the problem make no requirement for reversing or bringing the cutter spindle back to the starting point, and that, therefore, his solution does not comprise appurtenances for this purpose. As he points out, "Some such device would be necessary in a practical machine and could be readily applied to this solution." In enunciating the problem I considered that the restoration of the spindle to its original starting point after it had traversed the stipulated path, could hardly prove difficult with any mechanism that would cause the spindle to move as stipulated; and as such a requirement would complicate the problem more than I desired, I purposely omitted it. Such a provision has many prototypes in modern machine tools. Mr. Gargan's description follows:

"In the plan view *A* is the spiral of Archimedes to be described by the cutter spindle. In this case the radius vector is 16 inches and the curve is laid out according to the method described in the enunciation of Problem VII. In the longitudinal section *C* is the horizontal table on which the work is to be placed. This table is omitted in the plan in order to give an unobstructed view of the mechanism beneath. Projecting through a slot in the table which conforms to the path of the spiral, is the spindle *B*. This spindle rotates in the sliding block *D* and is driven by means of the miter gears *E* and *F* from the splined shaft *G* rotating in bearings in guide *Q*. From the driving pulley *H*, located outside the base, motion is conveyed to shaft *G* through shaft *V* (rotating in bearings in the frame) miter gears *I* and *J*, shaft *K*, gear *L*, pinion *M*, shaft *N* and miter gears *O* and P. Sliding block *D* is guided in ways in the rotating guide *Q*, which is bolted securely to arm *R*, which rests on the main frame *S*, and is driven by the worm gear *T* keyed to the lower end of the hub on *R*. The center of the hub on *R* is bored to receive the shaft *K*, which freely rotates therein. Worm *U*, which is driven from the main driving shaft *V* by means of the train of gears *W*, *X* and *Y*, engages with worm gear T, causing it to turn in the direction of the arrows, driving arm *R* and guide *Q* in the direction indicated by arrows in the plan view. This rotation causes the bevel pinion *Z* to roll in the circular rack *A1* which is bolted securely to the frame. Lead screw *B*[1] is keyed to pinion *Z* and engages a nut in sliding block *D*. The rolling motion of pinion *Z* on rack *A*[1] causes screw *B*[1] to turn in its bearing in guide *Q* causing the block *D* to travel outward along the ways. Rack *A1*, pinion *Z* and the lead of screw *B1* are so proportioned that block *D* travels the length of the radius vector—16 inches—along guide *Q* during the time that guide *Q* rotates once around its own axis. The motion of *D* along guide *Q* being dependent on the rotation of *Q* around its own axis, it follows that there is a fixed ratio between the longitudinal movement of *D* along *Q*, and the angular movement of *Q* about its own axis. With the ratio between rack and pinion and lead of screw shown, the cutter spindle will describe the spiral of Archimedes shown in the plan with a radius vector of 16 inches. The speed of spindle *B* is slightly increased when the guide *Q* is turning clockwise, owing to the pinion *M* sweeping around gear *L* in a direction opposite to the rotation of *L*. The gearing here shown will drive the cutter at high speed while following the path of the spiral at very slow speed.



PLAN
FIG. 5



Sectional Elevation
FIG. 5a

SOLUTION NO. 1 TO PROBLEM VII.

PROBLEM IX.

Referring to Fig. 7, a sliding block is required to be driven by a shaft whose center is at c^1. The distance $b\ c^1$ is

equal to the distance *b d* and *b d* equals three-fourths *a b*. The arc *c d* described from *b* as center, is 120 degrees. The point *c'* is located by the intersection of the arc *c d* by line *e c'* drawn through the middle point of *a b* and perpendicular to line *a f* making an angle of 45 degrees with *a b*. ***The geometrical center of the sliding block is required to pass from b to a and back again to b during each complete turn of the shaft.***

This is a go-as-you-please problem. There are no restrictions other than those included in the enunciation; but a simple solution is possible, and the more simple the better, provided a good mechanical construction is supplied.

Fly-wheel Explosion in Fly-wheel Factory.

In one of the numerous towns of the middle West there is a thriving concern engaged in the manufacture of mill pulleys and engine fly-wheels. Their fly-wheels are of excellent design and are constructed in the best possible manner. They had an attractive exhibit last year at the Louisiana Purchase Exposition, consisting of an immense fly-wheel of their make, and they issue a handsome catalogue, in which they show a picture of a large fly-wheel built by them to re-replace a wheel of another make that had exploded in a brick factory and caused a property loss of $20,000.

It will be understood from this that the given people are thoroughly conversant with the danger of fly-wheel explosions. They have devoted years to the study of fly-wheels, and are building fly-wheels of their own design considered to be as safe as human ingenuity can make them. They are, in fact, recognized fly-wheel experts.

Several months ago one of our agents called on this concern and suggested the advisability of their taking out a fly-wheel policy to protect their interests against loss due to the possible explosion of the fly-wheel driving their own factory. As might have been expected, the concern knew too much about fly-wheels to give our agent's advice the consideration it deserved. They thought fly-wheel insurance an excellent protection for factory owners in general, but considered that it would be of little benefit to them. They believed their wheel to be practically unbreakable.

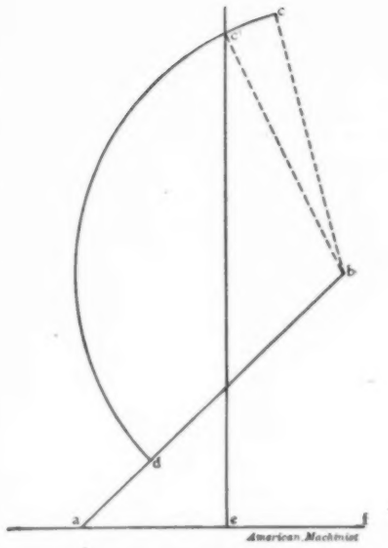


FIG. 7. PROBLEM IX.

Our agent admitted the excellent construction of their wheel and freely complimented it. He contended, however, that it was practically impossible to build an unbreakable fly-wheel. He explained that fly-wheels do not usually explode because of any weakness in their construction, but because of some accident to the governing mechanism of the engine, causing it to run away and explode the wheel by centrifugal force. He pointed out a number of ways in which slight accidents to the mechanism of engines had precipitated disastrous fly-wheel explosions, and urged them to take out a policy.

This interview, as we stated at the beginning, ocurred several months ago. Today we are in receipt of a newspaper clipping giving a graphic account of the explosion of this very fly-wheel. And the accident occurred just as our agent said it might occur. We quote as follows:

"The huge fly-wheel in the engine room of this factory burst with terrific violence. Heavy pieces of the wheel were hurled in every direction, demolishing everything in their path. The engine was wrecked, other costly machinery was damaged, a huge swath was cut in the roof, and brick walls were shattered. The entire plant, employing about three hundred men, is shut down. The accident was caused by the failure of the governor of the engine. This allowed the speed to increase to such an extent that no fly-wheel, however strong, could have stood the tremendous centrifugal stress that was produced."—*Monthly Bulletin of the Fidelity & Casualty Co.*

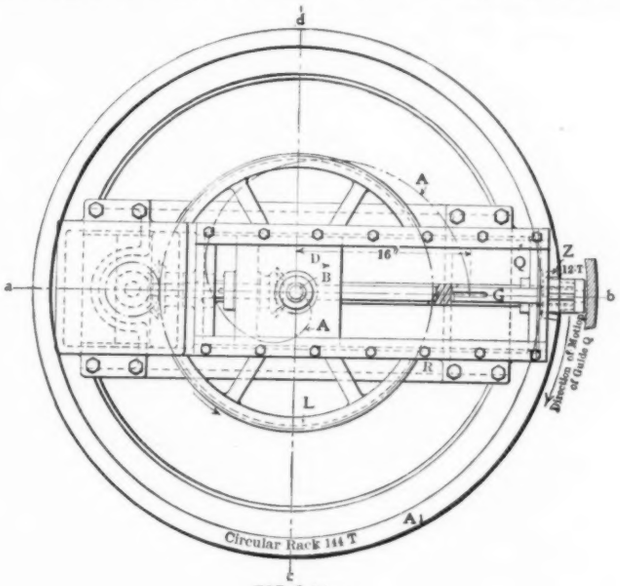


FIG. 6 Plan

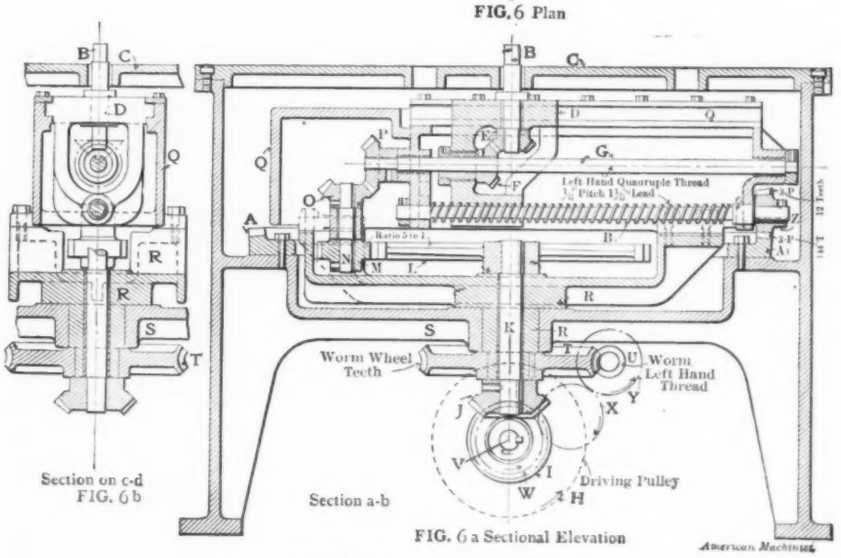


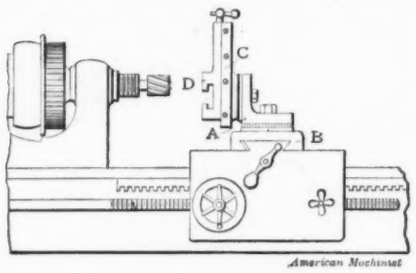
FIG. 6 a Sectional Elevation

SOLUTION NO. 2 TO PROBLEM VII.

Letters to the Editor.

A Cheap Milling Device for the Lathe.

Some years ago, having occasion to do quite a little light, plain milling in a shop whose principal "equipment" consisted of one good 14-inch lathe, with compound rest, I got up the rig shown in the enclosed sketch. This rig is so simple and obvious that it hardly seems possible that it can be new; yet I have never run across it in my travels, and have several times



A CHEAP MILLING DEVICE FOR THE LATHE.

turned in the suggestion in small shops where there was no miller, and it has always been warmly welcomed and given good service on light work.

Its cardinal virtue is its cheapness and simplicity, for aside from the vise, which may often be on hand, the whole cost for any lathe having a compound rest should not exceed five dollars. Another point in its favor over some of the clumsy lathe-milling makeshifts I have seen, is the quickness with which it can be set up and removed without in any way interfering with the regular uses of the lathe.

All there is to it is to get out a pattern for an angle casting *B*, both faces of which are circular, the distance from the base to the center of the vertical face being the height from the top of the graduated circle (tool-block bearing) on the cross-slide to the center of the lathe spindle. The diameter of the faces on the angle piece should be the same as the inside of the graduated circle on the slide for the bottom face and about ½ inch greater for the vertical face, in order that the latter may be chamfered for about ¼ inch and marked off in degrees if desired. After both faces are turned up bolt it to the cross-slide *B* in place of the usual tool-post block, with the vertical face accurately at right angles to the lathe ways, and make a setting mark to correspond with zero on the graduated circle. This should be carefully done that future settings may be quickly and positively made. The compound rest *C* is now bolted to the vertical face, as shown, and a light cut taken—with an end-mill in lathe spindle—across tool-post seat to insure truth, using the cross-feed of the lathe and feeding down at the end of each cut with the compound rest screw until the whole face has been gone over. Any small machine vise may now be bolted to the tool-post seat *D*, after which the compound rest should be carefully set, in its new position, so that the travel is exactly vertical and zero marks made for resetting.

It is surprising what a range of light work may be done with this simple rig, an end-mill or two fitting the lathe spindle, and a few cutters to run on an arbor between centers. Longitudinal and cross feeds are provided by the lathe carriage, and vertical feed by the compound rest, while horizontal angular adjustments are gotten by swiveling the angle block on the carriage, and vertical ones by swiveling the compound rest on the block. Naturally, it is not intended for heavy work, but it is something more than a makeshift, and on very light work it is sometimes even handier than a miller, while on experimental and die work it is almost invaluable in a shop without a regular milling machine. In using end mills the base is swiveled at right angles to the lathe bed, as shown, while with cutters on centers it is, of course, swung parallel with bed.

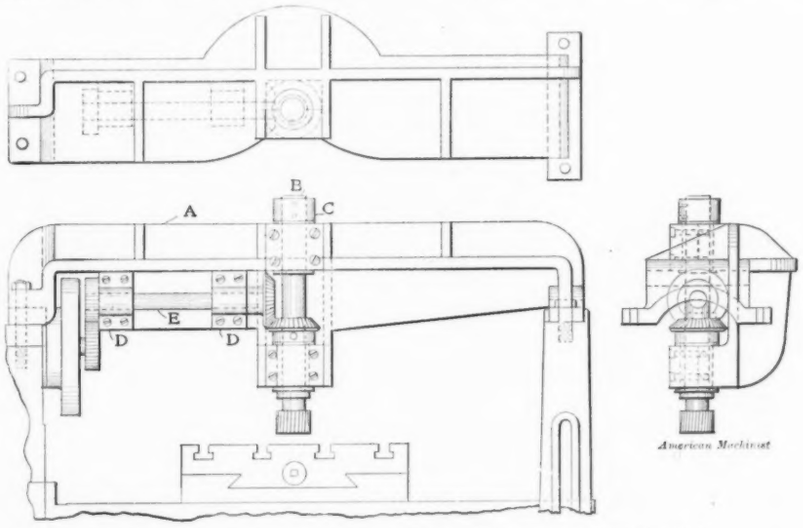
Both cross and longitudinal feeds, geared as fine as possible, may be used if needed, and both screws may be used for indexing; or perhaps it would be more proper to say dividing. With a little ingenuity its applications are quite varied. I once cut several small sections of rack, using a cutter between centers and indexing by the lead screw, and at another time did a very good job of drilling and reaming on some small plates with rows of ⅛-inch holes requiring accurate spacing and perfect alinement. A bushing held in the center rest served to steady the point of the drill and start the reamer fair. In this case I used the cross-feed screw, with a micrometer collar for indexing. The lathe was new and the screw not worn, and the results were entirely satisfactory. There were several of these plates to do, and as they had to be right, the cost of the rig was saved on this one job alone.

M. C. Conwell.

Vertical Milling Attachment for the Horizontal Boring Mill.

When the first lot of machines of a new design was under construction we found that a light, open-work frame could not be machined to advantage on the planer. The superintendent at first thought that the frames would have to be sent to a shop which was equipped with large vertical milling machines, but I suggested that an inexpensive vertical milling attachment for the horizontal boring mill could be made which would do the work all right, and, after explaining what the thing would look like and how it would work, I was told to go ahead and get out the drawings and to build it. There was no attempt made at elaborate designing or workmanship, because the thing was to be gotten out cheaply and in the shortest possible time, the main object in view being to have it do the work.

One end of the gray-iron body *A* was machined to a seat on top of the previously planed flanges of the cap of the main spindle bearing of the horizontal boring mill, and the other end was fitted in like manner to a planed seat on the yoke. Two holes were drilled in the spindle end of the body to match up with the holes for the cap-screws, and for holding it there



VERTICAL MILLING ATTACHMENT FOR A HORIZONTAL BORING MILL.

two screws were made. Two holes for bolts were drilled in the yoke end of it, and holes to suit were drilled and tapped in the yoke. The body was then bolted in place and laid out for doing the necessary planing and boring true with the top of the platen. Capped bearings were provided for the cutter spindle, the jaws and caps for the bearings were bored and faced to receive split bronze bushings, which were flanged at each end, the flanges fitting snugly over the jaws and caps, and in addition each half of the bushings was doweled in its center to its place. The cutter spindle *B* was made of .60 per cent. carbon steel, and, being intended only for

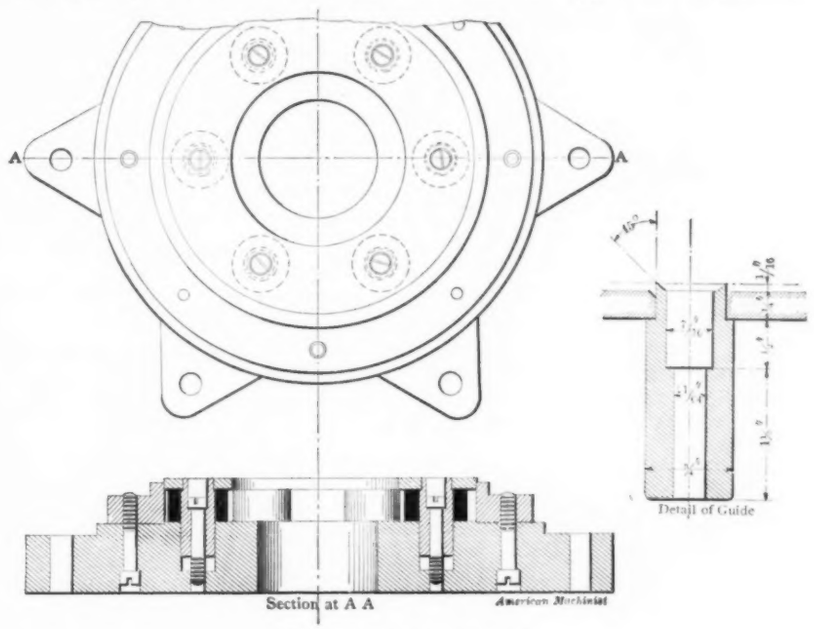
end milling, one end of the thrust shoulder was reduced and threaded to suit the threaded holes in the end mills that were chosen to do the work. To save the time of making a splined collar and a pair of jam adjusting nuts, and threading and keying the spindle to suit, the offset-hole method of adjusting was resorted to, and two 60-degree holes were drilled in the upper end of the spindle for the screws in the take-up collar. This collar, *C*, was made of gray iron, with two holes drilled and tapped to receive the 60-degree pointed adjusting screws. One of the holes was drilled to coincide with the uppermost hole in the spindle when the collar rested on the upper bearing and the thrust shoulder on the spindle touched the lower bearing, and the second hole was drilled to be 1-16 inch higher than the other hole in the spindle, so that when the upper screw was released and the lower one tightened the collar would be advanced toward the bearing and take up the wear. The intermediate shaft *E*, which transmitted motion to the cutter spindle with the aid of gears from the main spindle, was a piece of cold-drawn shafting, running in unlined bearings in the gray-iron brackets *D D*, which were fastened to the body with screws and dowels. A pair each of miter and spur gears were brought. One of the miter gears was fastened to the cutter spindle with a taper pin, and the other was fastened likewise to one end of the intermediate shaft, and on the other end of this shaft one of the spur gears was keyed. The other spur gear was keyed to a taper shank which fitted the hole in the spindle of the boring mill. The front view in the illustration shows the attachment mounted on the machine, with end mill in place, ready for use. The gears were covered with guards, which are not shown.

Before the lot of frames were finished, we found that by making the attachment we had practically added another valuable machine to the equipment of the shop, for hitherto the boring mill sometimes lay idle for considerable periods of time, and the satisfaction given in this job convinced us that the machine with the attachment could be utilized for much of the rougher kind of end milling during the intervals when there was no boring to be done.

H. E. R. MANBRAND.

Punch and Die Stripper.

One of the principal features of a combination punch and die is the means for stripping the scrap and ejecting the punching. In the die shown (which is for 8½-inch blanks) the throw-out may be adjusted and also the stripper for the punch without disturbing the setting of the die. It will be readily seen from the sketch that the punch may be placed in the die and supported by parallels at the required height and then placed in the press and set. The throw-out is then dropped in and screwed down, and then the stripper is placed over the punch and set 3-32 over the cutting edge. We use a small ratchet screw driver for putting in the screws, but a bent screw driver will answer the same purpose.



8½-INCH BLANKING DIE.

It will be found that with the adjusting screws for stripper and throw-out tapped in from the face as shown instead of from the back it is easier to set the dies and there is practically no danger of having large combination dies injured when setting. If the stroke of the press is too short to allow the throw-out or stripper room to get in, the throw-out may be screwed down below the edge of the die and the stripper above the edge of the punch, and after being set, they can be adjusted to their proper heights above the cutting edges of the punch and die. The section at *A A* shows the guides with the rubber in position over each guide.

It will be seen that as soon as the punch strikes the throw-out it presses it down into the die, the guides sliding over the screws which remain stationary in the die block, while the same motion takes place in the stripper. Springs may be employed with the same result as rubber.

F. LAUER.

St. Henri, Quebec.

An Accident.

A picture properly goes with this story but, as it looks like any old collection of broken parts, it can be seen by the absent treatment.

Very suddenly one morning and without any preliminary warning, the different parts of the valve gear and fly-wheel governor of a 14x14, direct-connected, Harrisburg engine began to scatter themselves about the premises and the engine came to a stop, as all well behaved machines ought to do. After the debris had been collected and the breaks examined, there was no flaw to be found in any of the broken parts. When the piston valve was taken out, however, bruised places were found on the valve and bushing; the latter being cracked. In the exhaust port below, a piece of polished iron, about the size of a large peanut, was found and on it were dents on both sides where it had been pinched; stopping the valve and setting things to breaking outside.

No one can tell the exact sequence of events in a case of this kind, as pins, levers, weights and springs all get out of their proper orbits and disturb the equanimity and safety of the attendants, each of whom can tell just how near his head different pieces passed. There was not, to outward appearances, anything the matter with the piston and rod, but they were taken out and an oval hole ⅝x¾ inch was found through the piston head. On removing the follower, one section of the spider and that part of the bull-ring and follower next to it were found badly worn and brightly polished, and the adjusting bolt and lock nut for that section were missing.

It is hard to believe that a stud 4½x¾ inches, could get worn down to a polished peanut without giving some notice to the ears of some of the attendants, two or three of whom are always present. A small hole had also been worn through the follower into a counterbored hole, which could not be seen until after the bolt had been removed, but of course it had allowed steam to flow through in both directions, effectually removing all trace of pulverized iron. The broken or loose stud had been in one of the sections of the spider

above the center and its getting out did not affect the centering of the piston which, all the others being tight, had continued to run true.

Whether iron when pulverized fine enough acts as a lubricant, I am unable to say, but about a pound and a half must have gone out through the cylinder and valve bushings; yet they were in good condition. There is not mechanical clearance enough between the piston and head for the "peanut" and I must conclude that it escaped from its cavity on a recession stroke of the piston and that it was carried into the exhaust port where it was caught, as shown by the marks, when the valve was closing on the crank end. This would give a tension strain on the valve gear, and as suggested at first, there was something doing for a few seconds. The position where the valve stopped was such that the port on the head end was open just a little and of course the engine could only run as long as the momentum of the fly-wheel and generator would carry it. PETER H. BULLOCK.

Tools for Machining Large Fillets.

Fig. 1 shows a slotter tool for machining large fillets. Piece *A* is a forging faced at *a* and *b*, and bored to receive the stem of tool holder *B*. At the end of this stem is fitted a small gear *c*, that meshes with worm *d*, whose shaft turns in brackets *dd*, bolted to piece *A*. The shaft is square at one end to fit handle *e*.

Fig. 2 shows a tool for turning large fillets. Forging *C* is slotted at *f*, to receive combination gear and tool holder *D*. Body *C* and gear *D* are bored for central pin *g*, on which the gear turns.

The worm has a long stem that is supported by means of three brackets secured to *C* and is square at the end to receive the crank handle.

Both tools have given perfect satisfaction and have proved to be time savers when large fillets have had to be slotted or turned with accuracy. J. MENEGUS.

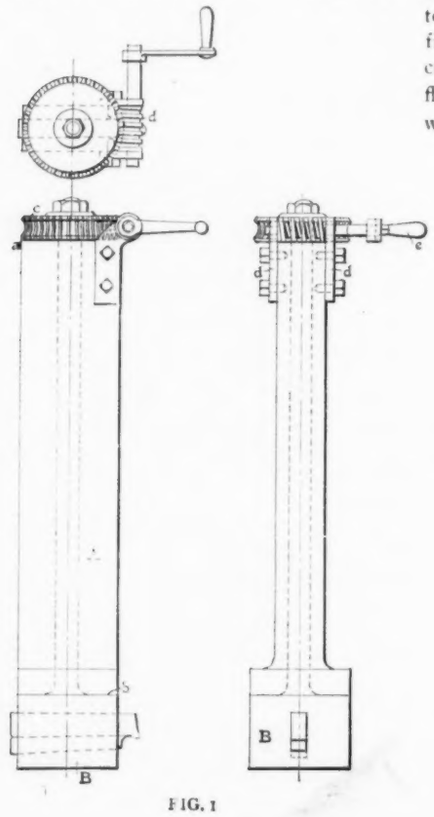


FIG. 1

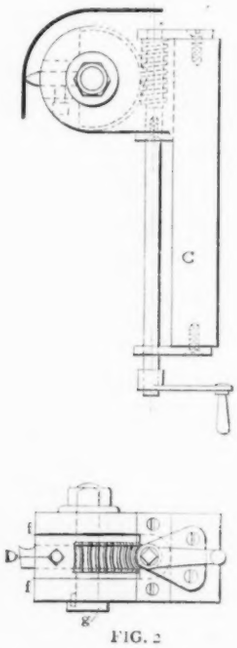


FIG. 2

TOOLS FOR MACHINING LARGE FILLETS.

Some Kinks for Patternmakers.

I send you some sketches of a few kinks I have tried and find very convenient. These may also be of interest to those of your readers who, like myself, cannot get

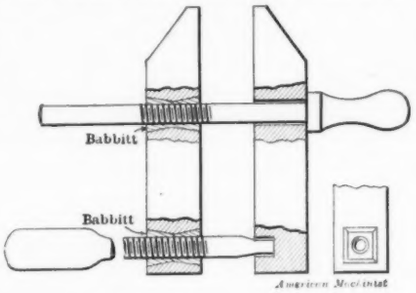


FIG. 1. BABBITTING A WORN WOOD-SCREW NUT.

along without a kit of tools and something to tinker with at home once in a while.

Fig. 1 shows a method of fixing up the thread in a set of wood clamps. The old thread is sawn away with a keyhole saw to a square hole, beveled to the center from each side so that the section at the center is, say, about ¼ inch larger across flats than the outside diameter of the wood screw. Next the screws are set up

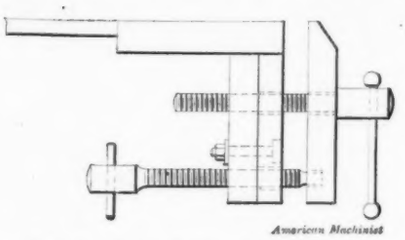


FIG. 2. A WOOD CLAMP AS A VISE.

in their proper positions and babbitted, a coat of white lead being applied to the thread where it is poured, thus giving clearance to the screw thread.

It will be found that the beveled section will make a very substantial nut and one that will be tight in the clamp, as the shrinkage in cooling tends to tighten it.

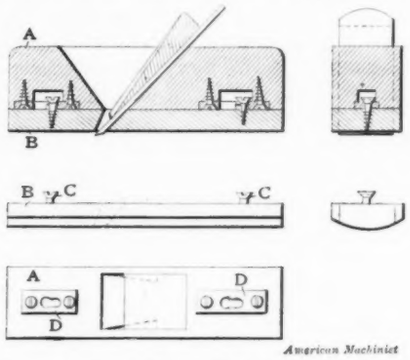
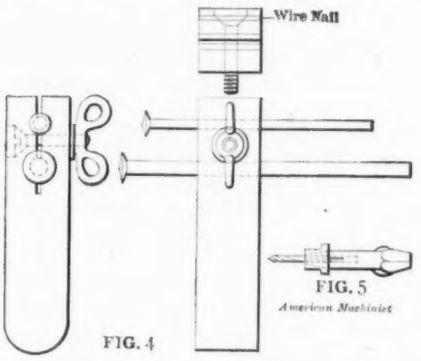


FIG. 3. A PLANE WITH INTERCHANGEABLE BOTTOMS AND IRONS.

Fig. 2 shows how a light vise can be made from a wood clamp to apply to a bench.

Fig. 3 shows a plane with a removable base piece. I noticed one of these in a patternmaker's kit of tools and was not content till I had made one for my own use. Any outline of plane iron can be used, all that is necessary is to make a base *B* to correspond, and insert the two screws *C* and *C* so that they will fit into the two plates in *A*, marked *D* and *D*. These plates have the top edges slightly beveled off and by adjusting the wood screws out and in, a very nice tight joint can be obtained.



A SCRIBE GAGE AND A SMALL CHUCK.

Fig. 4 shows a gage that is an improvement over the ordinary home-made one, having only one scriber and being locked by a wood screw.

Two large wire nails are used for scribers, their heads being sharpened as shown. For the binding device a flat-head machine-screw thumb-nut and washer were used, the machine screw being countersunk and a small wire nail driven through the slot in head to hold it in place and keep it from turning.

There are times when it is very handy to have a small chuck to use in a common brace. Fig. 5 shows one that is inexpensive and at the same time will do good work. It will be recognized as the end of an awl, such as shoemakers use; the chuck end is pulled out and a taper shank filed on the end. These can be bought at any hardware store, and have a small wrench to tighten up the chuck.

ERNEST J. LEES.

Cleveland, Ohio.

Stops for Setting Thin Plates in Chuck Jaws.

Here is a suggestion which I have found useful when chucking plates thinner than the height of the jaw steps, it being required to turn the outer face.

The scheme—which might be worthy of consideration by chuck manufacturers—consists in placing adjustable stops or jacks on the chuck face between the jaws. There might be a few tapped holes put in the face by the chuck maker, but as a makeshift use three or four pieces of gray iron or steel about like Fig. 1, flat on one side, drilled and tapped for 7/16 or ½ inch set screws. I used this arrangement on a Westcott chuck having holes through the body near the outer edge, through which long bolts, of a size to screw into the tapped holes, were placed from the back. One for each plate thus keeping them in position by clamping to the chuck face.

Set screws with check-nuts are adjusted in the plates. They can be set to the same height against a tool end clamped in the tool post and at the same time to a height that will bring the outside face of the work convenient for machining.

When the work is placed against the stops and the jaws closed there is no getting away from the cut and a number of pieces can be faced to the same thickness by means of a stop at the left of the carriage. An assortment of set screws of various lengths should be on hand to give heights to correspond with the different jaw steps. Fig. 2 shows plates in place on the chuck.

E. J. BOWERS.

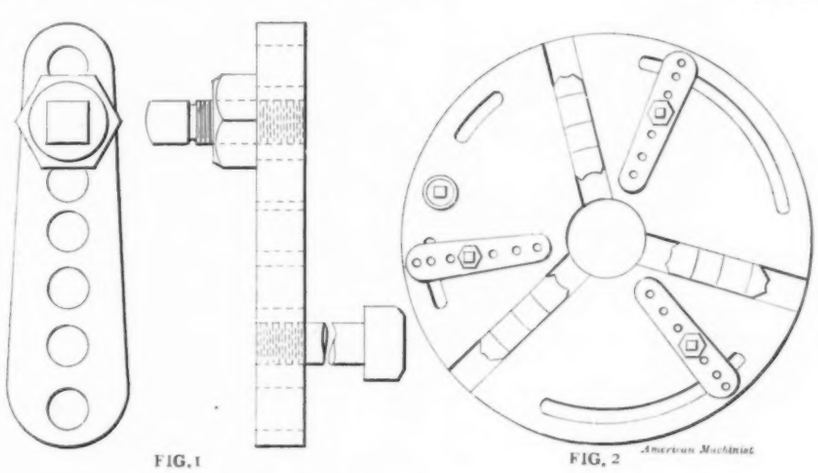


FIG. 1 FIG. 2

STOPS FOR SETTING THIN PLATES IN THE CHUCK JAWS.

A Foot-Press Job.

I am sending you herewith sketches of a job done on a foot press. The finished piece is shown in Fig. 1 and is made of seamless brass tube annealed. The piece is completed in two operations and is not removed from the press until after the second operation. The piece is shown with die in Fig. 2 after the first operation, the punch leaving the ears turned up at about 45 degrees. To flatten these out a piece of tool steel is inserted as shown by the dotted lines at *A* and the punch acts as a hammer. The slot at *B* is for the knock-out *C*.

HERMAN JONSON.

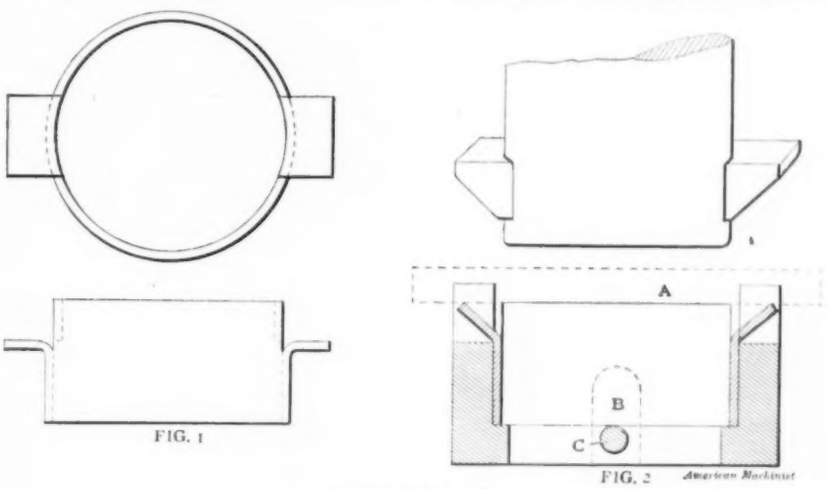


FIG. 2

A FOOT-PRESS JOB.

Dixie as a Philanthropist.

Some years ago a salesman who was selling goods for a friend of mine dropped into the shop. After finding out that I was not in want of anything in his line, he struck me for a loan of five dollars. As he had a whisky breath strong enough to hang one's hat on, I pleaded poverty. Several weeks later he made the same request with the same result. Thinking the matter over I decided that it was my duty to my friend to inform him of the conduct of his employee. Of course it did not make any difference to me, but the salesman might tackle some of his other customers in the same way with the possible result that my friend might lose trade.

Some time after arriving at this conclusion I met my friend and after extracting a promise from him to treat the salesman fairly, I told him the story.

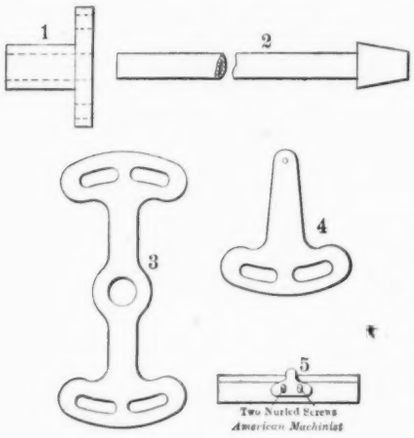
After hearing me through he said, "Well Dixie, Jones is a very good man; he handles one class of trade very successfully; he is the best man I ever had among the brewers and distillers. In handling them he is compelled to drink heavily but he never takes enough to prevent his getting any orders that are to be had. I agree with you that it would not do for him to approach some of my customers for a loan, I'll put a stop to that. How much did you say he wanted to borrow?" "Five dollars each time," I replied.

Several months later I was in my friend's office and he asked me if Jones had approached me for a loan since I spoke to him last. On receiving a reply in the negative, he said: "I'm glad it worked right." "Glad what worked right? You didn't say I told you about the two former occasions, did you?" "No," he replied, "after you left I sat down and did a little figuring from Jones' point of view. I came to the conclusion that it must cost him something to get the orders from the breweries and distilleries, so I raised his wages five dollars a week and gave him two per cent. extra commission." Jones

visits the shop still at frequent intervals but does not know how Dixie got his wages raised. DIXIE.

Lining Locomotive Slide (Guide) Bars.

An account of the method used to line up the slide bars of a locomotive as prac-



LINING LOCOMOTIVE SLIDE BARS.

ticed in England, may be of service or interest to some of my American brethren. The part marked 1 in the sketches represents a neck bush accurately ground on the cylindrical parts outside and in to fit the gland recess in cylinder and the dummy rod 2 respectively; 2 is a dummy rod made of stout tube with welded ends; this is ground on the parallel part and taper to size of standard rods, 3 represents guides for leading end of cylinder ground in the hole to fit the dummy rod, and a loose fit in the slots for cover studs. When a tail-rod is used, a neck bush, similar to 1 is used as a guide in the tail-rod gland recess in the cover. These tools are used for single-bar guides.

For four-bar guides 4 is a piece of flat stock shaped as shown with a small hole to take string, 5 is a straight edge with height attachment used as a scribing block, set to ½ height of crosshead.

The method of procedure with single-bar guides is obvious from the sketches; the bar is set fair with the cylinder walls, the slide is lined to correspond with the taper part of the dummy rod, when the latter is fair to the hole in the crosshead. The method with four-bar guides is:—The string holder 4, with string through is secured to studs by nuts, the string led through gland opening, and over a bolt and nut wedged in opening of spectacle plate;* a weight is tied to the string; next the string is set accurately to the center of the cylinder at both ends, the bolt being adjusted to effect this. The bars are put into place and the straight-edge 5 is used to find their position with relation to the string; the bars being lined to suit the bolt holes are then broached out, while the bars are secured by cramps; this having been done, the string is dispensed with, crosshead put in place after the bars have been tested for spring, and the top bars are adjusted to the crosshead so that it moves freely from end to end of the stroke.

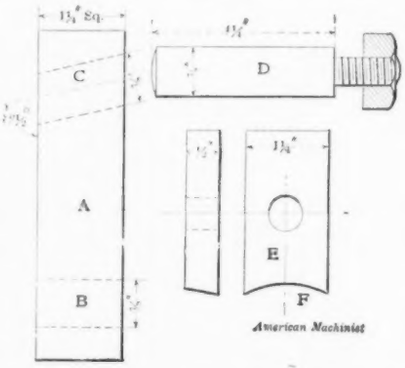
When setting bars on an inside type engine, the four bottom bars are leveled all over in the same plane and the procedure is as above, the top bars being set to the crosshead. A. L. HAAS.

London, England.

*What is called *guide-yoke* in the United States.—Ed.

Cutting Ratchet Teeth in Some Special Wheels.

I recently had a number of "tape-wheels" to make for cigarette machines. These wheels are mild-steel castings 12 9-16 inches diameter by 1½-inch face, and have 900 ratchet-shaped teeth cut across the periphery. As there were only a few of these to make, I did not consider it advisable to make or have made a form milling cutter to cut a number of teeth at once, but started to cut them with a single angular cutter. The first wheel took a day



THE FORMING TOOL AND THE RIG FOR MAKING IT.

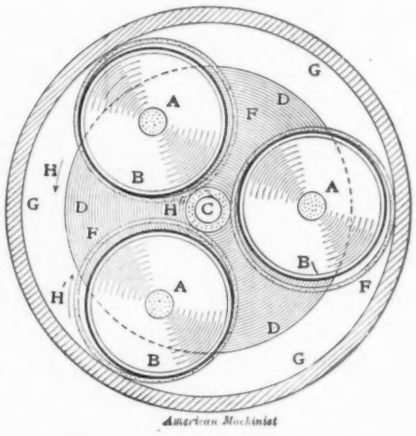
and a half to make, so I cast about to devise some other way of doing them. The following is the means I finally adopted, with the result that the remaining wheels took only about an hour each to do. I mounted the miller dividing head on the shaper table, set the index to cut 36, and cut 25 teeth at a time with a forming tool which was bolted direct to the clapper block, and fed down to a stop. The forming tool was made as follows: *A* is machine steel 1¼ inches square with two ⅞-inch holes in it: one, *B*, bored square with *A*, and the other, *C*, bored at an angle of 7½ degrees with *B*. A stud *D* was then driven into *C*, and left projecting about 3 inches, the outer end being reduced and threaded ⅝ inch U. S. standard, to hold the tool blank *E*. An arbor was driven into *B*, mounted on the lathe centers and the surface *F* tooled with a boring tool, till the distance from *F* to the center line equaled 6⅛ inches. The whole rig was then transferred to the miller centers and 25 teeth milled at *F*. The tool was then removed and hardened and ground on the face, after which it was ready for use. Needless to say, I had to clamp all the slides on the shaper pretty tight, as the tool had quite a cutting surface; but I had less trouble from chatter than I expected. I sharpened the tool once for each wheel, though it hardly seemed to need it. JOHN P. WHEELER.

The Centrator Friction Speed Gear.

While in Sweden I found a very remarkable simple and effective friction gear for increasing the speed of a shaft, without belts or gears, and without taking up any appreciable room. It was applied to a centrifugal machine for separating the cream from milk, for which purpose high speed is required.

With reference to the annexed illustration, there is affixed to the driving shaft—which in the case of the milk centrifugal had about 670 turns a minute—a disk *D*. On this there are fast three journals, *A*, *A*, *A*, parallel to that of the disk itself, and on each of which there rotates a disk *B*, outside of which there is a steel ring *F*, about 2 mm. or 1-13 inch thick, enough larger than the disk which it surrounds to give it play. These rings are pressed by the rolls *B* against the inside *G* of the circular frame, and roll also against the central pivot or journal *C*, so that they become somewhat oval, or rather elliptical. This central journal *C* is held in place only by the steel rings, and has no bearing proper in the sense of a journal as usually understood.

Rotation of the disk *D* in the direction of the arrow *H* (say against the sun) causes the rolls *B* to drive the rings *F* in the direction of the arrow *H'* (sunwise); and these in turn drive the central pivot *C* in the direction of the ar-



A FRICTION SPEED CHANGING GEAR.

row *H"* (against the sun). With the proportions adopted for the cream separators, the inner pivot, which is axially in line with the driving-shaft, gets between 5000 and 6000 turns per minute without appreciable slip. There is but little friction, and this is (with the exception of that of the journals *A*) mostly rolling.

The balance is perfect; the bearings do not run hot, the device is noiseless, strong and effective; and further, it is reversible in two senses, that is, it is just as adaptable for reducing speed as for increasing it, and can be run either right handed or left handed.

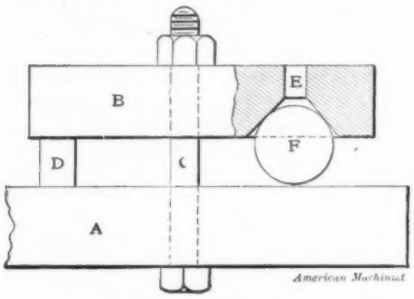
The maker is the Centrator Company, Stockholm.

R. GRIMSHAW.

Hanover, Germany.

A Simple Jig for Drilling Balls.

Having a number of balls to drill I made the jig shown. *A* is the platen of the drill press. *B* is a piece of machine



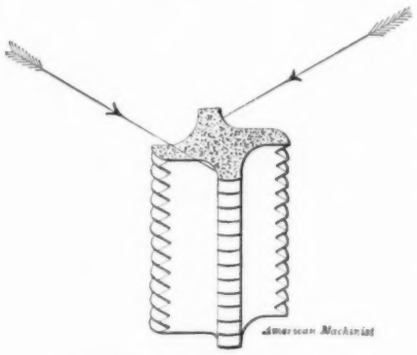
JIG FOR DRILLING BALLS.

steel drilled through at *E*—the size of the drill to be used to drill the ball *F*—and countersunk so it will seat on the ball. Another hole is drilled for the bolt *C*, it is then case-hardened. The packing piece *D* is of such thickness as to bring *B* parallel with *A* when the ball *F* is in position to be drilled, and the bolt *C* is tight.

F. R. WILLIAMS.

Getting Broken Taps Out.

Seeing in the AMERICAN MACHINIST some tools for getting out broken-off tap ends, made me think it might be worth while to give my way of getting them out. It is very much like the old way of using a



GETTING BROKEN TAPS OUT.

drift or blunt cape chisel and a hammer, only instead of one, two drifts and two hammers are employed (see illustration). Two men start in with very light blows to get in unison and when the blows are in time their force is increased as much as is necessary.

When one man is driving, most of the blow is spent in driving the tap end against one side of the hole and therefore it often fails to come out. With two men driving with the same force, the result is purely turning and it has never failed me.

It is necessary of course that the break should be near the surface which is generally the case. J. SCHURING.

[Though this kink is old, it is still too little known, and is wonderfully effective.—Ed.]

Attachment for an Inside Micrometer —Cutting Keyways in Pulleys where Machine is not Available.

Fig. 1 shows the inside micrometer A with the measuring rod B in place. C, D

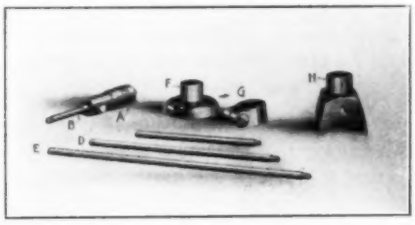


FIG. 1. THE MICROMETER DISSEMBLED.

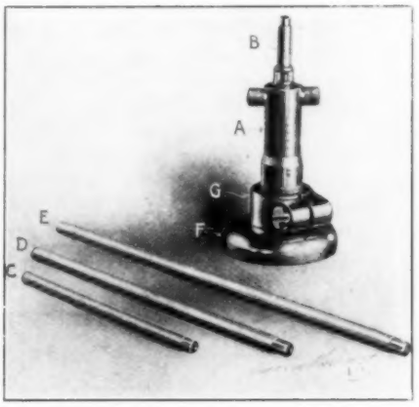


FIG. 2. MEASURING FROM A FLAT SURFACE.

and E are also measuring rods of various lengths, which are interchangeable with the rod B. F, G and H are attachments. Fig. 2 shows the fixture F as base with the micrometer A inserted so as to have the measuring end just flush with the base, which insures correct reading of the micrometer. It is secured by clamping the collar G which in no way interferes with the adjusting screw of the micrometer.

This is a convenient tool for measuring between flat surfaces or for using as a height gauge.

Fig. 3 shows the attachment H with the micrometer attached in the same manner as in Fig. 2, and mounted on the arbor I, the measuring end coming in contact with the arbor which insures correct reading This has proved to be an almost indispensable tool for measuring between shafts, arbors, etc.

Having twelve pulleys 7 feet 6 inches diameter, in the hubs of which keyways were to be cut ¾×⅜ inch and 8 inches long, the following method was devised:

Fig. 4 shows pulleys after the keyways

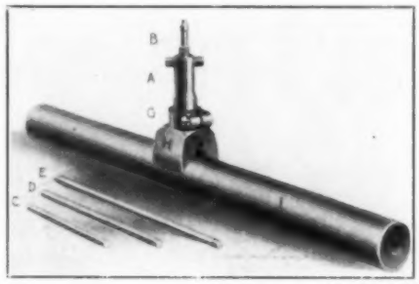


FIG. 3. MEASURING FROM A CYLINDRICAL SURFACE.

F have been cut. Fig. 5 shows the broach guide A, the broach B and shims C.

The broach guide A is 4 inches diameter by 10 inches long, with a flange on one end and a slot ¾ inch wide by ¾ inch

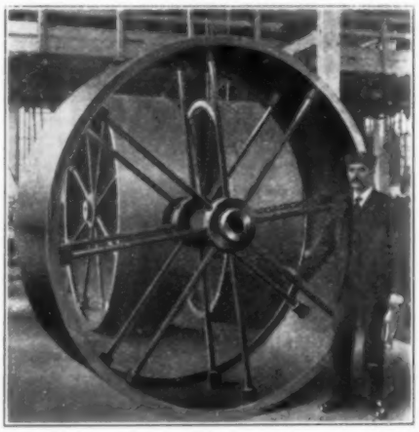


FIG. 4. THE FINISED KEYSEATS.

deep. The diameter of the guide is made about .002 inch larger than the hole in the pulley for about two inches of its length so as to insure a driving fit to prevent its

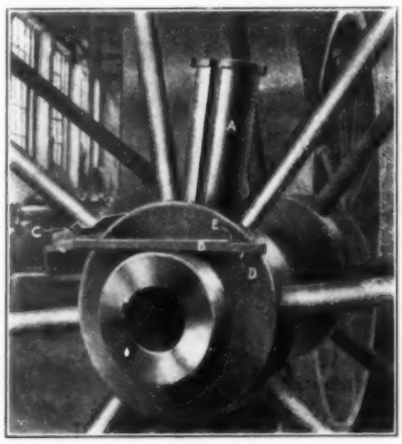


FIG. 5. THE KEYSEATING TOOLS.

moving while keyway is being cut. The broach B is made of tool steel about

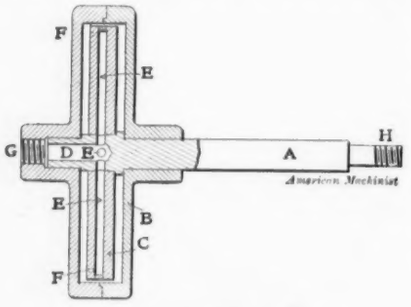
14 inches long. The guide end D is 2 inches long, ¾ inch wide and ½ inch thick. The cutting edge is at E where the broach is ¾ inch square and is slightly cut under to give clearance, the important size being the width. The shims C are of sheet iron about .02 inch thick, one of which is added each time the broach is driven through the keyway, which is done with an ordinary five pound sledge hammer.

We have found this a very successful method of cutting keyways in such an emergency as the above as well as making a first class job. J. A. SKERRY.

Providence, R. I.

An Air Grinder.

The accompanying sketch shows an air motor we built for light grinding purposes. It is a turbine of the Hero or reaction type. The wheel or disk *C* is made of bronze, pressed on steel shaft *A*. The wheel is about 4½ inches in diameter. The shaft *A* was first turned, and 5-16-inch hole *D* drilled; after pressing on the



AN AIR GRINDER.

disk we drilled the four ⅛-inch holes *E*, and plugged the ends. We then drilled four 1-16-inch holes through the side at a tangent, as shown at *F*. Drilling these holes through one side instead of on the circumference takes care of the end motion, holding the shaft against one collar all the time. The hole *G* is tapped ¼-inch gas pipe; this forms the air connection. The size of this tool was governed by the castings available. The two pieces of the body *B*, which are fastened together with machine screws, are made of brass. The sketch shows the tool as first constructed, and it worked very satisfactorily. As it will run very fast (from 12,000 to 15,000) it is advisable, if it is used very much, to make adjustable bearings, also to provide the shaft at the air end. Drill four ⅛-inch holes through the body *B* for exhaust. We have used this tool principally for grinding centers, chuck jaws, etc. While probably not as efficient as a compound condensing Corliss engine, for a portable, simple, reliable tool to do the work when you want it, it has proved its worth, and can be made and used in almost any shop where compressed air is available. W. T. H.

A "Feeler"—Locating Blanks on Drawing Dies.

Fig. 1 is a sketch of a feeler gage, which is a very handy tool. It is made from tool-steel 0.25 inch wide, and tapering in thickness from 0.01 to 0.045 inch, with an extension at one end for a handle.

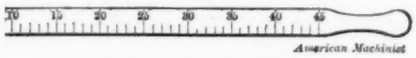


FIG. 1. A TAPER FEELER.

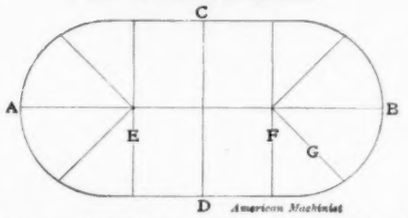


FIG. 2. LOCATING A BLANK ON A DRAWING DIE.

Fig. 2 is a diagram to illustrate an easy way of locating blanks upon a drawing die before the actual size of the blank is determined. To explain, when the die is laid out, center lines should be scribed upon it as *A—B* and *C—D*, then when a blank has been made ready for trial, lines should be drawn upon it in the same way.

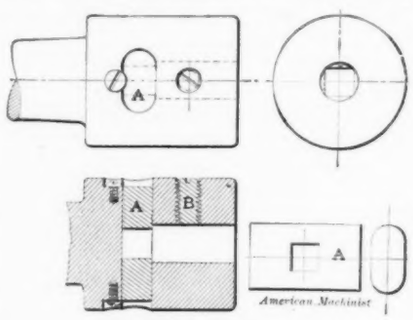
It follows that when the lines upon the blank are in alinement with those upon the face of the die, the blank will be located true with the drawing part of the die. In the same way when the blank is found the gage can be fixed without any calipering.

Other lines drawn as at *E*, *F*, *G*, will facilitate the getting of a correct blank, as they will show where the blank should be made larger or smaller as the case may be. CYCLO.

B——, England.

A Tapping Socket.

This tapping socket was made to use in a drill press. It has done good work, and is very convenient to handle, having



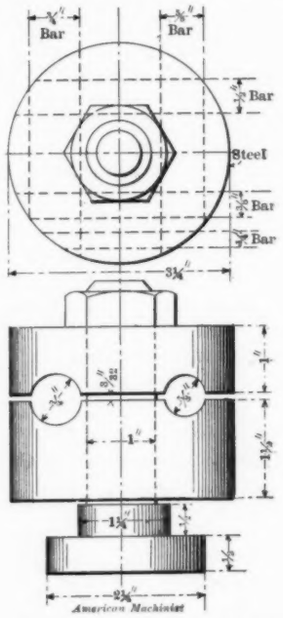
A TAPPING SOCKET.

no projecting parts. The body of the tool is made of machinery steel, and the driver *A* is of cast steel and hardened. The body should be bored to fit the shank of the largest tap that will be used, and bushings made for the smaller sizes. The bushings should have a clearance hole in one side to allow the screw *B* to pass through. This screw holds the bushings in place when they are used, and is run down onto the shank of the tap to prevent it from falling out of the socket when the tap is being backed out of a hole, or at other times when it is not down on the work. The drivers *A* made an easy fit in the slot and with holes to fit the squared ends of the different sizes of taps, are removed by taking out one of the screws *C*, the heads of which are set in counterbored holes, and allow the driver to have a slight end play to adjust itself to the variation in the taps.

M. H. BALL.

A Multiple Boring-Tool Holder.

The illustration, which I think is self-explaining, shows a multiple boring-tool-holder for use in place of the regular tool-



A MULTIPLE BORING TOOL HOLDER.

post. As shown it will take bars from ¼ to ¾ inch inclusive. The centers of the holes are the center height of the lathe.

Iowa. H. F. KILLEAN.

The Stock was Green, but the Workman was not.

A certain machinist was employed in one of the largest and best known machine shops in the East which turned out very fine work. The man had been there only a few weeks, when to the surprise of his superintendent and fellow workmen he was seen packing his grip. When asked what it meant, he remarked that he had received "word from home to come at once." In a few days he returned, asked for his money, and was told by the foreman that the superintendent wished to speak with him regarding the work he had done.

In a short time the superintendent came

into that department and Storms was the first man seen. He greeted him with—"Storms are you going to leave?" "Yes sir, as soon as I get my money.'" "Well, we've been looking over your work while you were away and find some in bad shape, the shafts are all inside of grinding sizes and two are below finish size. We are in a hurry for that machine, it will be a very expensive one and unless you can give some possible cause for the bad work I shall be obliged to deduct $10 from your wages."

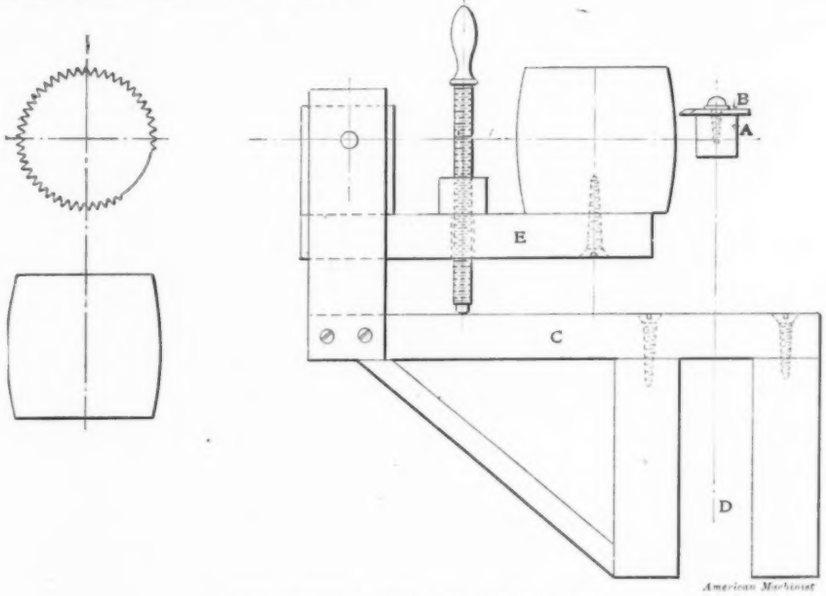
Storm was one of those witty fellows who always had a ready reply, and he suddenly broke out with, "Well, when I started the job you told me as you have to-day that you were in a hurry for the machine. I worked carefully and steadily and I guess the work is up to your standard; possibly those two shafts were turned from green stock and shrunk. I think it came from the lot you bought from my friend Howe about a month ago simply to get that 'rake off.' Am I right?"

Storms didn't leave, and the $10 wasn't deducted. S. W. GREEN.

Making a Grooved Pattern.

Some time ago we received an order for a pattern of the shape shown in the accompanying sketch.

It was to be about nine inches in diameter and six inches long, with V-shaped corrugations running from end to end, and as the pattern was barrel shaped, these



THE PATTERN AND THE GROOVING RIG.

grooves were difficult things to make without taking more time than the job warranted.

The blank was turned up in the usual way, and then the patternmaker rigged up the apparatus shown to cut the grooves:

A piece of wood *A* was put in the centers of the lathe and on it was screwed a cutter *B*. Then a frame *C* was screwed to the wooden shears *D* of the lathe, and to this was pivoted a swinging frame *E*, carrying the pattern.

One half of a carpenter's clamp, with the jaw fastened to the frame *E*, served as a feed screw and nut. The grooves were laid out on one end and the indexing was done by hand, as no very great accuracy was required.

The roll was successfully corrugated with this apparatus in much less time than it could have been done in by hand.

W. ALTON.

Preventing a Gear from Slipping on its Shaft—A Hurry-Up Job.

The sketch shows how I quickly secured a gear wheel that shifted from its position. It was the driving gear on the wheel axle of a sweeper. The superintendent, seeing that he did not have enough electric sweepers to keep the five different routes open, decided to make use of the old horse-car sweeper by pushing it over one of the routes in front of the sand car. They went out, but soon came back with the report that one of the brooms would not revolve. The superintendent, without knowing what was wrong, told me that I had just 20 minutes in which to fix it.

The brooms of a horse-car sweeper are driven from the sweeper axle; Fig. 1 shows this, being a top view in which *A A* are the wheels, *B* the axle, *C* the bevel gear on the axle, which I found shifted out of mesh with the pinion *E* of the broom shaft *H*. Fig. 2 is a section of Fig. 1 on lines 1 and 2. The guides and mechanism for raising and lowering the brooms, and the framework of the sweeper, made it impossible to use a wrench or hammer. I gave up the idea of doing anything to the four 1-inch bolts that clamped the gear *C* to the axle, it being a split gear and kept from turning on the shaft *B* by the key *I*. There was nothing to keep it from slipping along the axle, except the friction on the shaft. With the aid of a bar and a small screw-jack I forced the gear *C* back into mesh with the pinion *E*. I then went in the woodshop and got a bundle of hardwood strips—the same as used for the car floors. I also got a saw, some wire and pliers. I then went under the

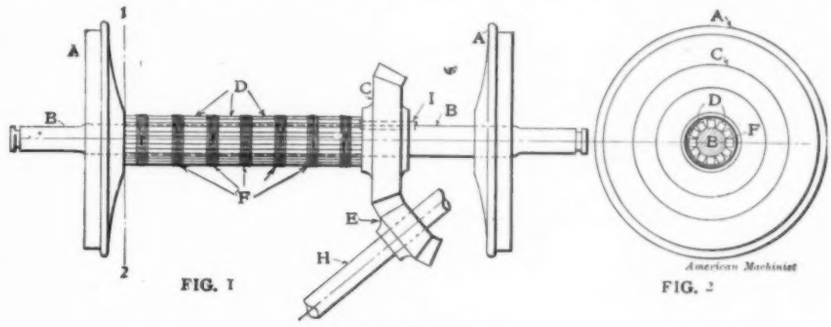


FIG. 1 FIG. 2

THE REPAIR.

sweeper and measured the distance along the axle between the wheel hub *A* and the hub of the gear *C*, and sawed a number of the strips this length. I then placed them around the axle and bound them to the axle at short intervals with wire to keep the strips from buckling. *F* indicates the wire windings and *D* the strips.

To do this job right would require several hours, but the hardwood strips were all right and stayed on till the sweeper was taken to the shop and converted into an electric sweeper. E. W. J.

An Improvised 4½-Inch Tap.

I received a telephone message one Saturday afternoon to go down to the Blank wagon works next day and see what was the matter with the throttle valve.

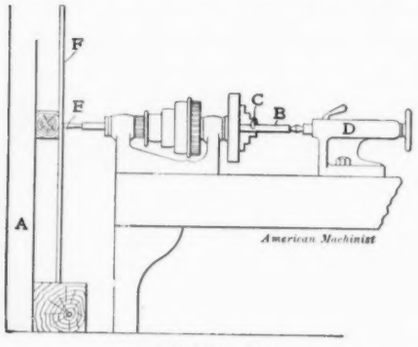
I went down next morning, and found a four-inch valve that was little different from an ordinary globe valve. The brass seat had screwed nearly out, and this caused the leak. I took the measure, screwed the seat—which was somewhat disfigured—back in place and next Sunday went down to put in the new one. In the meantime the firm had reported the valve getting rapidly worse. When I took the valve apart I found that the seat had worked entirely out, and had turned over so that in attempting to close the valve, the ring had been bent

almost into a bow knot. When I tried to screw in the new seat, I found that the thread in the valve was so badly mutilated that the hole would have to be re-tapped. Taps as large as 4½ inch with twelve threads per inch, were unheard of in our town. But I made a good one in half an hour. I took a good hardwood wagon axle, and cut off about a foot, then with a draw shave, I made it fit the threaded hole for a couple of inches on one end; I then found a ½ inch 12 thread tap, and putting the oak plug in a vise with a small block of hard wood between the plug and the vise jaw close to the end, I bored a 7-16 inch hole in the edge of the plug, allowing the bit to cut into the block an amount equivalent to the depth of the thread. I fitted the tap into this groove pressing it in tightly with the vise. With this tap I straightened up the threads in the valve till they looked almost as good as new. The new brass seat was screwed into place, and after grinding it a little, the valve was reassembled. This job was done five years ago, and has not been heard from since.

CHAS. A. TRASK.

A Drilling Job.

Here is a little job that might be of interest to some of the boys. An old friend of mine started a little shop on his own hook, but unfortunately, in this instance, he was a better machinist than business man, and only succeeded in making a comfortable living out of his place. I was passing one day and noticed a lot of ¾ inch boiler plate, about 6



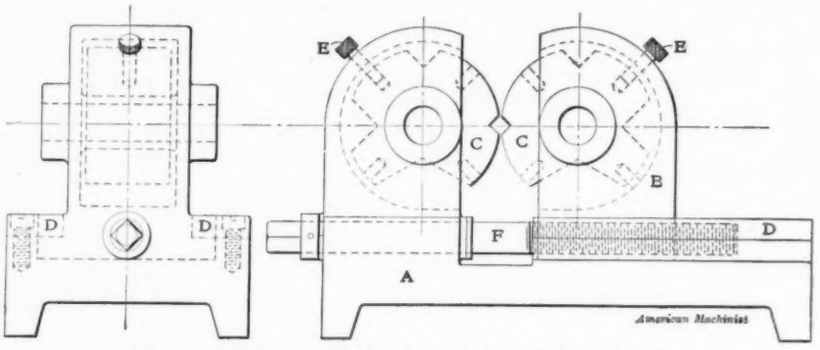
A DRILLING JOB.

feet by 4 feet, standing at the door, with a 1¼ inch hole drilled through the center. As the shop only contained a little bench drill, small forge, vise, and 20 inch lathe, I went in to see how those holes got there. He had done it with the lathe. It had a hollow spindle that could take a shaft through it two inches diameter. He had blocked the plates up against the wall A behind the lathe, drilled a socket hole in one end of a 1½ inch shaft B, put a set screw C about two inches from the other end (allowing the head to project about ¾ of an inch), chucked the set-screwed end, leaving the shaft about 1-100 inch loose with one jaw driving the set screw. The tail stock D provided a first class hand feed for the drill E. There was about two inches of driving surface available on the chuck jaw. The plates F were drilled in reasonable time. W. L. McL.

Fixture for Holding Cylindrical Work on the Drill Press.

The drawing shows a fixture, which I have found very handy for holding cylindrical pieces on the drill press. It consists of a gray iron body, *A*, with a sliding piece, *B*, *A* and *B* containrevoluble jaws, *C*, having four different sized Vs on their periphery, which gives the fixture a wide range. These Vs are locked into position by the pins *E*; the sliding piece *B* is held down by the steel gibs *D*, and is operated by the screw *F*.

G. F. PAYNE.



FIXTURE FOR HOLDING CYLINDRICAL WORK ON THE DRILL PRESS.

A Micrometer Surface Gage.

The enclosed sketch, Fig. 1, illustrates a very handy tool for the milling machine or planer, and also for quickly and accurately obtaining the heights of projections on plane surfaces and other work of a similar character.

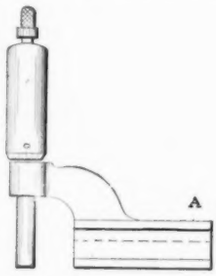


FIG. 1

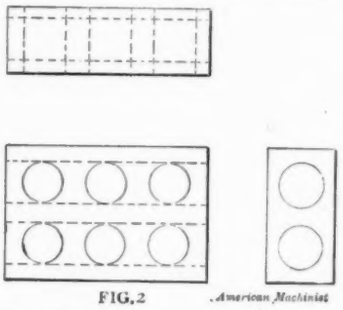


FIG. 2

American Machinist

A MICROMETER SURFACE GAGE.

The base *A* is made of machine steel, carbonized and hardened, with the exception of the hole in the arm into which is pressed a 1-inch micrometer head, this hole being bored true with the bottom of *A*, which has previously been ground or lapped to a true surface.

To increase the measuring capacity of the tool a machine-steel block, Fig. 2, also carbonized and hardened and accurately ground 1x2x3 inches, permits the tool to be used for measuring from 0 to 4 inches. To make the block of light weight, eight ⅝-inch holes are drilled as shown.

G. V. HUBER.

The Performance of Some English High-Speed Machine Tools.

As it seems to be nearly an acknowledged fact, over in the States, that English machine-tool manufacturers are in the front with high-speed machinery, I thought a short description of the results obtained by some of our makers would be of interest to your readers.

The Armstrong - Whitworth Company deals more with the very heavy class of tools, as the description of its exhibit at Liège, at page 352, will testify. In this article are shown two lathes of 12- and 18-inch centers, corresponding to the 24- and 36-inch sizes of the American lathes. The latter machine is credited with a cut 1½ inches deep (3 inches reduction in diameter), ¼ inch advance of tool per revolution at 38 feet per minute cutting speed. Some idea of the massive proportions of this lathe may be obtained from the fact that it is driven by a 60-horsepower motor.

Another firm which has devoted considerable attention to the extra heavy type of lathe is the Tangye Tool & Electric Company, of Birmingham, which, I believe, builds high-speed lathes up to 24-inch centers, fitted with all gear heads. Its 24-inch lathe is credited with cuts 1 inch deep with ¼-inch feed at 32 feet per minute, and 1 inch deep with 1-10 inch feed at 80 feet per minute, the power absorbed

being 65 horse-power. The machine was designed to remove a ton of chips per hour.

Another firm devoting all its energies to manufacturing high-speed lathes is Dean, Smith & Grace, of Keighley, who make all sizes from 6½- to 20-inch centers, the 8½- and 12-inch sizes of which, together with a sample of work done, will be found at page 345, Vol. 27. The sample shown illustrates a 5¾-inch diameter bar of steel from which the lathe spindles are made. One cut is taken for each diameter, the smallest diameter being 4½ inches, giving a cut ⅝ inch deep, which is taken at a cutting speed of 80 feet per minute, with a feed of 8 cuts per inch, the whole bar being roughed down in twenty minutes.

From the above, which is not a complete list, it will be seen that we are fairly up to date in the heavier type of lathes, and, of course, it must be understood there are scores of other firms who make high-speed lathes which are capable of taking medium cuts at high speeds—machines which are more applicable to ordinary practice where it would be neither necessary nor preferable to "remove" even half a ton of chips per hour.

J. Archdale & Co., of Birmingham, make a specialty of high-speed drilling machinery, both radial and upright. Some of the results obtained by this firm are as follows: 1-inch holes at 8.2 inches per minute; 1¼-inch holes, 5 inches a minute; 1½-inch holes, 3 inches a minute; and 2-inch holes at 1.4 inches a minute, the material drilled being mild steel in every case.

Another firm which has given considerable attention to all classes of high-speed machine tools is Hetherington & Sons, Ltd. This firm makes a high-speed radial drill of 3 feet 6 inches radius, having a 2-inch diameter spindle and a gear-box drive with which they claim to drill 1-inch holes in gray iron 3½ inches thick in 18 seconds. The machine is designed to drill holes from ½ to 2 inches diameter, the speed provided for the ¼-inch drill giving a cutting speed of 45 feet per minute, the average of the whole series being 62 feet per minute.

I might say here that it is my opinion that drilling machinery, especially radial, is the most difficult class of machine to design satisfactorily for high-speed work. There are such a large number of bearings necessary to a radial that lubrication becomes a vital point. I think the radial drill of the future will be electrically driven, with the motor built into the drill head, and possibly the motion for raising and lowering the arm will be driven from the main motor, though it might have an independent motor. I am confident that the radial drill of the future will be made in this way, as the speeds required to run high-speed drills of the smaller sizes, up to their full capacity, is so enormous. The speed of the ¼-inch drill mentioned above is 720 revolutions per minute, and this through three or four pairs of gears and several bearings.

Another high-speed specialty is the Bateman planer, which is made in a full range of sizes by the Bateman Machine Tool Co., Ltd., Hunslet, Leeds. The 60x 60x144-inch size cuts at 60 feet and returns at 130 feet per minute. The 42x42x 96-inch cuts at 60 feet and returns at 165 feet per minute. With two tools at ⅛-inch feed it will plane 4,032 square inches in 30.35 minutes, and with a cut ⅜ inch deep, at ⅛-inch feed, it will remove nearly half a ton of metal per hour.

This machine is a very ingenious one; it has a combination fly-wheel and cushioning arrangement, the latter for the table and the fly-wheels for the pulleys, so that there is no great increase of driving power required at the reversal of the table, the stored energy of the fly-wheels being given to the pulleys just at the proper time.

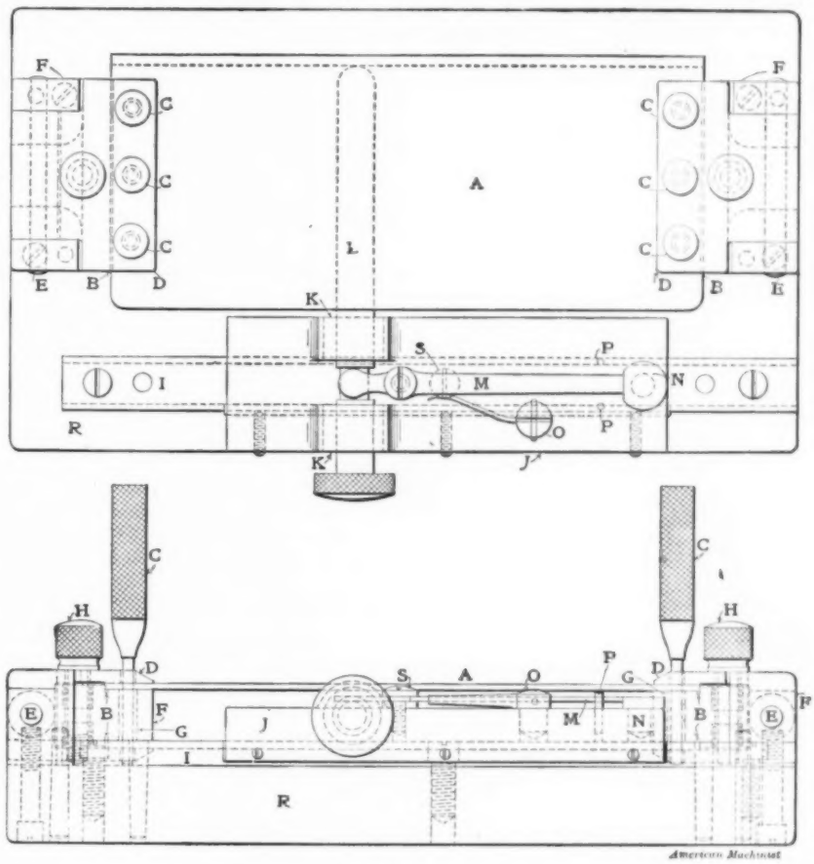
I hope this list, which is by no means a complete one, of the results attained by some of our makers will prove of interest to the readers of the AMERICAN MACHINIST. It will show them, perhaps, that we are not behind in this class of work; that besides making the steel, we can also make the machines to use it to advantage, and that English machine-tool builders have advanced tremendously during the last two or three years. It might interest your readers to know that the Bateman planer originated in Halifax—in Yorkshire.

I. SPEED.

England.

A Bench Gage.

I have been a constant reader of the AMERICAN MACHINIST for some years, but seldom see anything about bench gages except with micrometer measurements. Considering these very important on interchangeable work, I would like to say a few words in connection with them. Referring to the assembled sketch A is a ⅛ inch formed steel pocket. After being machined to the right shape, the length is gaged. As will be noticed a groove B is milled in each end of the gage .020 inch deep, to prevent the burr sticking in the



A BENCH GAGE.

corners, and permit the parts to be easily entered and removed from the gage. After drilling it is gaged again with six hardened, ground and lapped plugs C in the holes. The bottom is gaged at the same time; if it is not perfectly straight and at right angles with the holes it can easily be detected. The clamping device consists of two straps D on each side of the gage, made of machine steel and case-hardened; they are hinged and held together with a pin E on the body F. The middle is fitted with a screw H which is screwed into the bottom strap. Two spiral springs are placed between the two straps to keep them open while the work is being inserted. The nurled screw H clamps

both sides at once, the plug holes in the straps are .010 inch larger than the plugs. Hardened, ground and lapped bushings G are driven into the body F which is fastened into the body F which is fastened to the gray iron plate R with two screws and two dowels from underneath. The sliding mechanism consists of a 30 degree dovetailed piece I held to the plate with three screws and two dowels. It is made of machinery steel, case-hardened and lapped on all sides. On top slides the block J which is held with a gib and adjusted with three screws. On top two holes are bored to fit the hardened, ground, and lapped bushings K. In these bushings turns the hardened, ground and lapped plug L. This is made of tool steel. After being ground the center on the end is taken off and rounded to insure no cutting in the bottom of the work when gaging. On the other end it has a nurled handle to press it against the bottom when gaging. In the middle it is necked in and fitted to the rounded head of the multiplying hand M. This hand is made to register 5 to 1 and is held in the block J a turning fit on the shoulder screw S with a washer underneath. On the other end is marked the zero line which matches a similar line on the shoulder pin N. This is made the same height as the multiplying hand, and driven into the block. On each side of the multiplying hand two stop pins P are driven into the block to prevent the spring from breaking. On the side of the multiplying hand in the block is driven another shoulder pin O. This is slotted on top in the middle for a flat spring .02c inch thick which is held with a pin. This spring keeps the multiplying hand away from the work.

U. JUDEN.

A Turret Attachment for the Lathe.

The sketches show a turret I have designed for making duplicate parts of various kinds on an ordinary engine lathe where turret lathes are not available.

The head *A* is a casting with a boss or hub thrown out of center and bored out to fit the spindle of the tail stock of the lathe. It is provided with two lugs which are fitted with screws for clamping tightly in position, the hub being split and slotted as shown so as to spring easily.

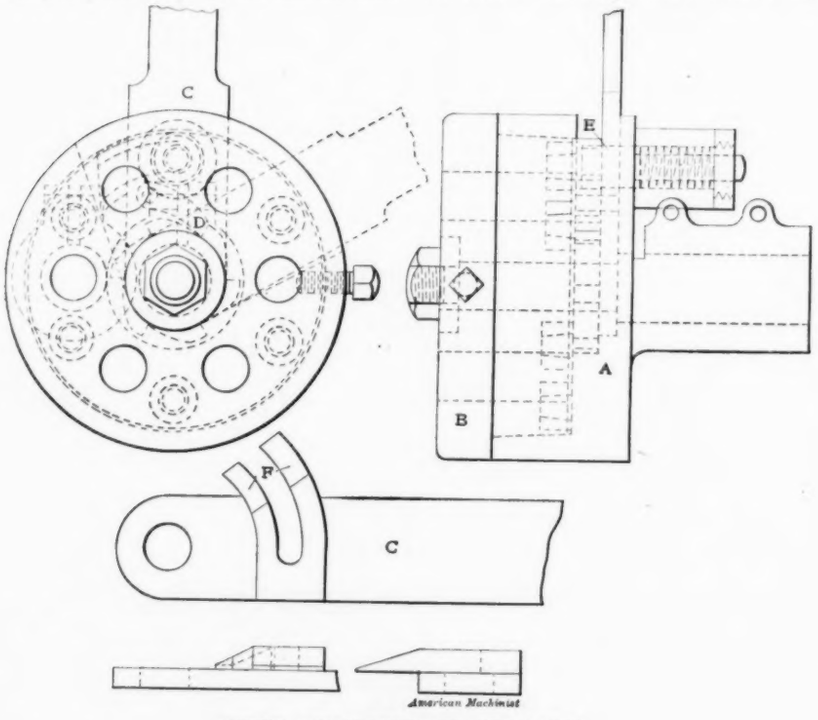
The head is bored out to fit the rotating member *B* that carries the tools and which is provided with six holes. The bearing is slightly coned so as to allow wear to be taken up if necessary. The rotary part of the head is fixed or held by a bolt through the center which is locked by a washer and a hexagon nut.

A section of the head is cored out for the lever *C* which operates the turret head in the usual way by an index wheel and pawl *D*. The locking pin *E* is forced into the index holes by a spring for which a boss is provided on the main casting. The pawl is pivoted on the lever and the lever itself is made as shown in the detail with a curved, slotted projection *F* which is tapered at the end. When bringing the lever up the slot straddles the locking pin and the tapered part of projection *F* coming in contact with a shoulder on the pin, forces it out of the index hole, thus freeing the rotating head.

When the lock pin is clear (at the highest point of the wedge *F* on the lever), the lever has then ¾-in. movement yet to travel before the end of the slot is reached. The pawl then drops into engagement with the index wheel, and when it is pulled forward the index hole is well clear of the locking pin before the latter is released by the wedge projection on the lever. As the lever is moved still further the pin is ready to catch the next hole when it comes around at the end of the stroke. The operation is very quick and the lever can be operated with one hand, leaving the other hand free to operate the slide rest. The head can be made in several sizes to suit large and small lathes, and as a special tool will be found very useful on work that is usually made on a capstan.

CHAS. PETITJEAN.

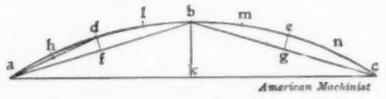
London, Eng.



TURRET ATTACHMENT FOR THE LATHE.

Plotting Circular Arcs of Large Radius.

Many of the readers of the AMERICAN MACHINIST are doubtless familiar with the method of constructing an arc of a circle by points shown in the accompanying illustration. The necessity for plotting the curve in this, or in some other way, arises when the outline of a plate is required which is to be bent into the form of the surface of a frustrum of a cone of great altitude, i. e., when the vertex of the cone, which is the centre of curvature, is inaccessible. The object of this article is to demonstrate the practicability of the method.



PLOTTING ARCS OF LARGE RADIUS.

We will assume that the length of the radius—the slant height of the cone—has been obtained by calculation; as well as the sine *ak*, and the versed sine *kb*, computed to this radius; and that it is required to plot several points intermediate between *a*, *b* and *c*. The construction is as follows: Draw the chord *ab;* bisect it at *f;* draw *fd* perpendicular to *ab*, making it equal to one-fourth of *kb; d* will be one point on the curve. Similarly the point *e* will be determined. Draw the chord *ad;* bisect it, and draw the perpendicular equal to one-fourth of *fd;* we thus obtain *h*. In like manner *b*, *m* and *n* will be constructed. The process may be continued indefinitely, and any number of points plotted. The method is an approximate one; but the degree of accuracy is very close for small angles.

Observing that *kb* is the versed sine of the arc *ab; fd* is the versed sine of *ad*, i. e., of one-half of *ab;* also that the perpendicular *h* is the versed sine of one-half of *ad*, and so on, we are enabled to plot as many points as we please. The accompanying table shows that for *small angles*, the versed sine of an angle is practically one-fourth of one of double the value. In drawing the envelope of the frustrum of a cone whose vertex is at a great distance, only small angles are involved. We may therefore accept this plot of an arc

of a circle as sufficiently accurate for this purpose:

	Versed Sine.	Versed Sine.
1°	.000152	
2°	.000609	.000152
4°	.002436	.000609
8°	.009732	.002433
16°	.038738	.009684
32°	.151952	.037988

TABLE OF VERSED SINES.

We observe that the versed sine of as large an angle as 16° does not differ very much from one-fourth of the versed sine of 32°. FREDERIC R. HONEY.

A Car Wheel Boring Mill.

The photograph and line drawing, illustrate a single belt drive applied to a car wheel boring mill. Twe changes are obtained on the countershaft by means of a shifting belt and three on the machine, making six changes in all.

In changing the speed the belt is shifted to one of the three pulleys shown at the rear of the machine, the corresponding pulleys on the countershaft being of the same diameter. By referring to the line drawing, Fig. 2, it will be noticed that the middle pulley is keyed direct to the shaft while the two outside pulleys each

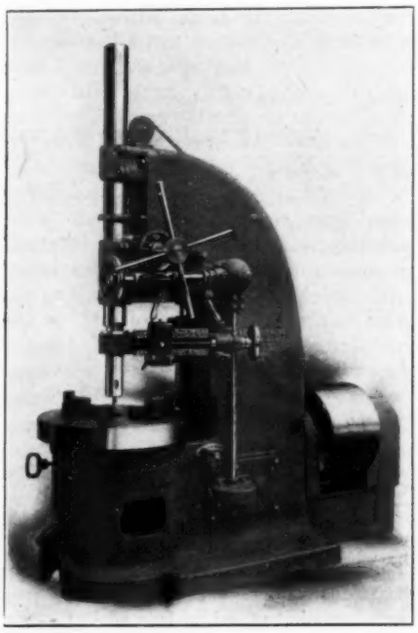


FIG. 1. A CAR WHEEL BORING MILL.

drive the shaft through back gears. When one pulley is running the others stand still, so that no gears except those directly driving the spindle are running. The result is a very smooth running machine. The wear on the gearing is also reduced to a minimum.

A silent rachet is provided in each set of back gears, which allows the entire train of gearing between this point and the belt pulley to remain at rest when the belt is on either of the other pulleys. The low speeds are obtained by shifting the belt to the outside pulleys, the direct high speed being in the middle.

In shifting from the low speed to the intermediate speed the belt passes across the high speed pulley without accelerating the speed above that of the intermediate speed. This is contrary to what might at first be expected, and is due to the ease with which the belt is shifted and the fact that the momentary slip of the belt due to the greatly increased power required for accelerating the speed prevents the speed from materially changing while the belt is passing the center pulley.

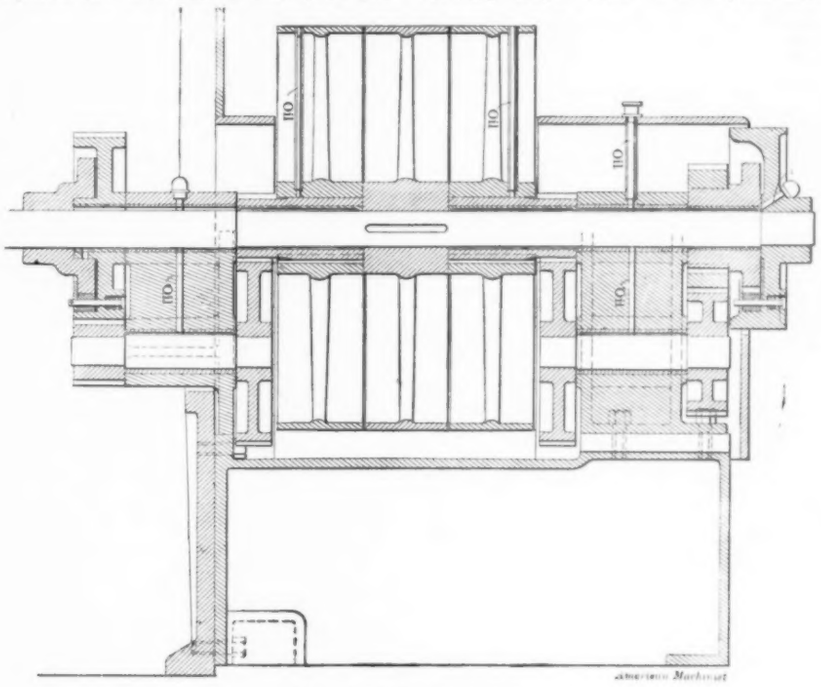


FIG. 2. DETAIL OF DRIVE.

The spindle is supported in adjustable taper bearings and the thrust is upon a large roller bearing.

This machine is manufactured by Baker Brothers, Toledo, Ohio, and is designed especially for boring street and mining car wheels and work of a similar nature.

Origin of the B. F. Sturtevant Company.

When, in the year 1857, B. F. Sturtevant, the young shoemaker of Norridgewock, Me., gave up his cobbler's trade and came to Boston to introduce and manufacture his ingenious pegging machine designed for doing away with the drudgery of manual labor of pegging shoes, he little thought this was the first step toward the building up of a great manufacturing company. A deep interest in all that pertained to the manufacture of shoes, naturally led him to introduce various other labor-saving devices, among which was a buffing wheel for smoothing the soles. The dust created in the use of this machine proved an annoyance until he hit upon an arrangement of exhaust fan for drawing it away. The only purchasable fan, of that day, was an extremely crude and inefficient affair. With characteristic thoroughness he designed and built a new type embodying many improvements. Its success in connection with buffing wheels, led, naturally enough, to its trial for the removal of refuse from wood-working machinery, and thence to its employment for handling all classes of light material, and its application for blowing forge, boiler and cupola fires. Foreseeing, even then, the vast possibilities of the business, Mr. Sturtevant established himself in a small way, with half a dozen workmen at No. 72 Sudbury St., Boston. It was soon evident that a different type of fan was required for the creation of the 10 to 16 ounce blast usually necessary in cupola furnaces. Naturally, with his experience along an entirely different line, he was comparatively ignorant of the details of pig iron manufacture, and even of the existing practice in the matter of blast production. But this was an incentive rather than an obstacle to him. Utilizing the income from his pegwood business, he deliberately undertook an exhaustive series of investigations upon the operation of cupola furnaces throughout the country. He conducted numerous experiments upon blowers of all imaginable sizes, shapes and designs, until he was able to intelligently evolve from them all a single complete design known as the "Steel Pressure Blower." At about the same time there was also developed a new form of volume blower after the general principles of the pressure blower but designed primarily for operation at lower speeds and for use where quantity rather than pressure was desired.

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Sending Money Abroad and its Effect upon our Exports.

We are informed by a report of the Department of Commerce and Labor that aliens residing here enrich Europe with money sent from here to their native lands, and it is stated that $50,000,000 have been sent in one year to Austria-Hungary. This opens up an interesting line of inquiry. Of course, we know that no actual money is sent to Austria-Hungary and that American money if sent there would be of very little practical use. What is really sent there are drafts on New York, post-office money orders, express money orders, etc., and these when they arrive in that country are exchanged for the money of Austria-Hungary, or are deposited in the banks of that country to the credit of the depositor. They thus become a claim upon America, and in one way or another they can be made good, or the values upon them realized only by something else which is sent from this country—something of value—merchandise in some form or other; or, gold. And if American indebtedness thus created abroad is discharged by the exportation of American goods, then it is bringing about a thing upon which we are in the habit of congratulating ourselves; that is, upon the volume and the value of our export trade, and upon the "balance of trade" in our favor, etc. Now if this sending of money abroad really enriches the foreign countries, and if at the same time the exportation of goods to meet our foreign indebtedness thus created enriches us to the disadvantage of the foreign countries, then how do these two things become reconcilable, the one with the other? When one has answered this question in an entirely satisfactory manner, in a manner which will bear examination from every standpoint, he will have gone very far toward acquiring a comprehensive knowledge of the nature of money and the functions it performs, especially in international trade; the fact being that money, as such, passes from one country to another to only a very small extent; also that there is something decidedly wrong with the generally accepted theory of the "balance of trade." It does not seem quite consistent for a department of our Government to issue bulletins congratulating American citizens upon the tremendous export trade they are enjoying, and at the same time to issue other bulletins, decrying the sending abroad of commercial paper, the only ultimate effect of which can be to promote such export trade. It would seem as though if one is good the other is good, because the one simply conduces to and promotes the other.

It is as true in the economic field as in mathematics or mechanics that every fact is consistent with every other fact. When two facts seem inconsistent one or the other (or both) are not real facts, or, we do not understand them. On one horn or the other of this dilemma the Department of Commerce and Labor must be impaled. We object to being congratulated on our export trade and commiserated on a thing which promotes it.

Packing Goods for Foreign Shipment.

We have commented upon the fact that the Consuls of each important commercial nation are continually urging upon the merchants of their respective countries to be more careful in the matter of packing for foreign shipments, and we have noticed that each set of Consuls seems inclined to consider the merchants of its own country the worst of the lot, and to hold up the merchants of all the other countries as examples worthy of being followed. For this reason there has been, perhaps, some disposition to discount the statements made by the various Consuls, but in the issue of the daily *Consular and Trade Reports* for January 22, there is an article on the packing of goods for foreign shipment which was prepared by Special Agent Crist, writing from Tientsin, China, and in this he gives a lot of reproductions from photographs showing the actual packing cases as they were received in that country. In some instances where goods had been packed in tin-lined cases, the wooden cases had entirely disappeared, and the tin linings had been ripped open exposing the goods. The illustrations show that the packing, however good it may have been in the estimation of the manufacturers or shippers, has manifestly been entirely inadequate to cope with the treatment it has received during transportation, and it is evident from this series of photographs, to say nothing of other evidence, that the subject must be investigated more carefully and that more attention must be given to it.

The "Bennington" Verdict.

So far as the general public can judge, the results of the trial by court-martial of the officers supposed to be responsible for what took place on the U. S. gunboat "Bennington," immediately before the disastrous boiler explosion, which occurred on that vessel in July of last year, are quite inconclusive and unsatisfactory. The commander of the vessel was reprimanded and Ensign Wade, who was actually in command, or was supposed to be responsible for the doings of the engine-room force, has recently been acquitted. Immutable physical laws have already inflicted the penalty for their violation upon those who were killed and injured at the time of the explosion. The trouble with such laws is, however, that they do not discriminate between the guilty and the innocent, or between those who are really responsible and those who are in no way responsible.

If officers of the Navy think that this verdict settles the matter then it is pretty certain that they are mistaken. It is a matter of common knowledge that things in the Navy are in a bad state. There is not merely a deficiency in the force of officers but the Personnel bill, like most others that are compromises and that fail to do full justice, is working badly. It has been condemned by officers who ought to know most about it. If there is no authority within the Navy itself for making a full and complete investigation and report, then Congress ought to order an investigation. As we have said before, the course of procedure followed in raising steam in the boilers of the "Bennington" on that fatal morning in July, 1905, would have disgraced a crew of intelligent boys. That such a thing could have occurred on board a U. S. Naval vessel is of itself sufficient to show that something is radically wrong in the organization. That something should as speedily as possible be discovered and made right, and if this is not done then let us hear no more of our great Navy and its great vessels and what they are able to do, nor of the necessity for building a lot more of such vessels.

The plain fact is that real engineers must do, and be responsible for, engineering work in the Navy as everywhere else, and there will be no cessation of trouble until things are put upon that basis.

American Institute of Electrical Engineers Building Fund.

The General Electric Company in view of the great importance and utility of the United Engineering Building, as a home and center for the engineering professions and arts, has made a contribution of $25,000 to the land and building fund of the American Institute of Electrical Engineers. President C. A. Coffin, who takes a warm personal interest in the matter, has also sent his own check for $5,000. The committee, which had already received gifts and pledges amounting to nearly $70,000, is greatly encouraged by this generous support of its work. The fund is now with other new subscriptions well over $100,000, and with renewed energy the committee has begun its canvass of the field with the object of securing the second necessary $100,000. About 600 members have already subscribed to the fund, and the committee expects to have no difficulty in at least doubling this number.

That the phonograph is a popular means of entertainment is obvious to everybody's ear but few will fail to be surprised at the fact that the output of Edison records last year was fourteen millions. The company is now forty thousand machines behind its orders.

New Tools and Machine Shop Appliances.

A MONKEY WRENCH.

Fig. 1 shows a monkey wrench, the adjusting nut of which may be disengaged from the screw, thus permitting the jaw to slide to any position for quick adjustment.

Between the projecting yoke of the sliding jaw and the nut there is a small spiral spring which keeps the nut in engagement with the screw. By referring to Fig. 2 it will be seen that the nut *A* has a slot *B* running through its entire length. By turning the nut so that the slot *B* is over the rib *C* on the body of

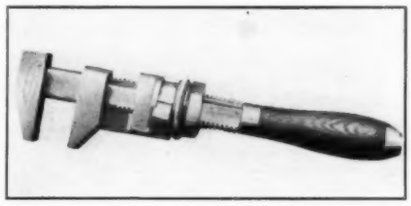


FIG. 1. A MONKEY WRENCH.

the wrench, a slight thumb pressure will throw the nut out of engagement with the screw and the jaw may be slid to the desired position. On releasing the side pressure on the nut the small spring in the yoke returns it into engagement with the screw.

The nut, besides having the usual nurled ring, has also a hexagonal part so that another wrench may be used to bring the jaws tight.

The wrench is made by the Uwanta Wrench Company, Meadville, Pa.

A 32-INCH SHAPER.

The illustration shows a 32-inch shaper designed for heavy duty. The cross-traverse screw is graduated to read to .001 inch, and is equipped with variable automatic feed, which can be changed from nothing to full feed while the machine is in motion.

The head swivels to any angle, The down-feed screw is provided with a graduated collar reading to thousandths of an inch, and has an offset handle, shown in the illustration, making it much more handy for the operator to manipulate.

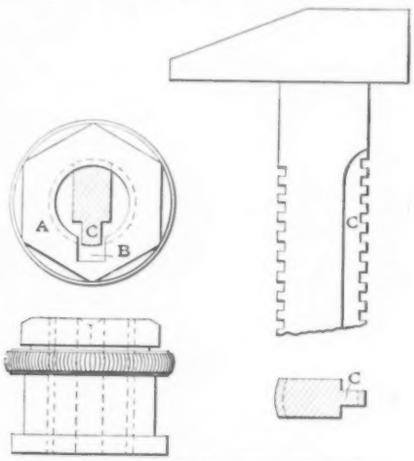
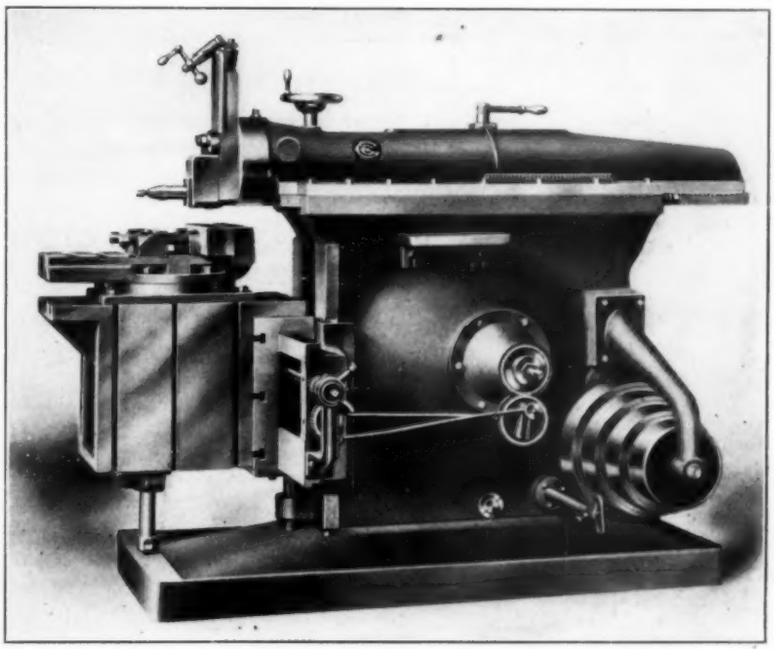


FIG. 2. DETAIL OF NUT AND JAW.

Full uength taper gibs are used throughout, each adjustable by means of a single screw. The ratio of the single gear is 7.2 to 1 and of the back gear 30 to 1.

An outer support for the table is supplied which runs on rollers. The elevating screw is telescopic and is provided with a ball thrust. Shafting up to 4 inches diameter may be passed through the column for keyseating.

This machine is made by the Cincinnati Shaper Company, Cincinnati, Ohio.



A 32-INCH SHAPER.

THE "UNIVERSAL" AUTOMATIC SCREW MACHINE.

The machine shown herewith, is of the multiple spindle type, there being five spindles, and the tools acting on all five bars of stock simultaneously. It is driven by three belts from the countershaft; two are used to drive the spindles through the medium of a central shaft and sleeve and spur gears. One of these gives the reverse motion for threading. The third belt drives the cam shaft through a worm and worm gear. The spindles are carried in a cylinder—as shown in Fig. 1, which is indexed to carry the work to the tools for the five stages of manufacture, the lower forward position of the spindle being the one for the stock feed movement, The cylinder is locked in each position by a taper plug which is carried in the cylinder casing. Fig. 2 shows the construction of the spindles and the arrangement of the chuck and feed tube for each spindle will be understood from this section.

There are two taper cones keyed to the spindle; the front one being driven on, the back one being adjustable for wear. These cones are of bronze, and run in hardened steel boxes. This is the reverse of the usual practice, the reason being that it is desired to take any wear which may occur upon the revolving parts. The spindle drive is ordinarily from the gear *A* on the central shaft sleeve to gear *B* connected by friction *C* with the spindle. For threading, however, a positive drive at a lower rate of speed is provided through gear *D* keyed to the central shaft and loosely mounted gear *E*, the latter carrying a spring-pin adapted to be engaged by a clutch lug on the rear face of cone *C* when this cone is released from gear *B*. This change from friction to positive drive is effected by means of a yoke *F* which is carried by spider *G* and actuated by a cam on the drum beneath as each spindle in turn comes opposite the die or tap holder. A pawl engaging a notch in the key in clutch cone *C* holds the positive clutch in position and takes the pressure of the clutch springs from yoke *F*.

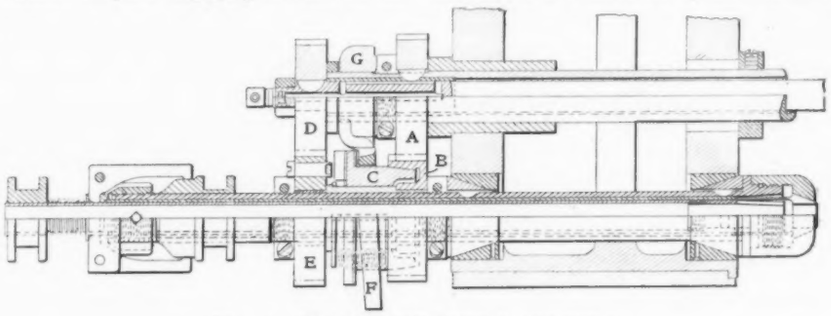


FIG. 2. SPINDLE CONSTRUCTION AND DRIVE.

Upon the thread die reaching the end of the cut and the spindle reversing, the pawl is tripped and the friction again thrown into action by the springs.

The arrangement of the locking pin and indexing mechanism is indicated in Fig. 3. The lock bolt is situated about midway of the length of the cylinder or turret and is withdrawn by cam-actuated lever *H*. The five pockets for the indexing pawl *I* are formed at the rear end of the turret, and the hooked pawl is operated by cams (and return springs) on disk *J*, the cams engaging with a pivoted plate *K* on which *I* is mounted. The forward movement of the indexing mechanism is limited by a screw which insures the cylinder being stopped with a hole di-

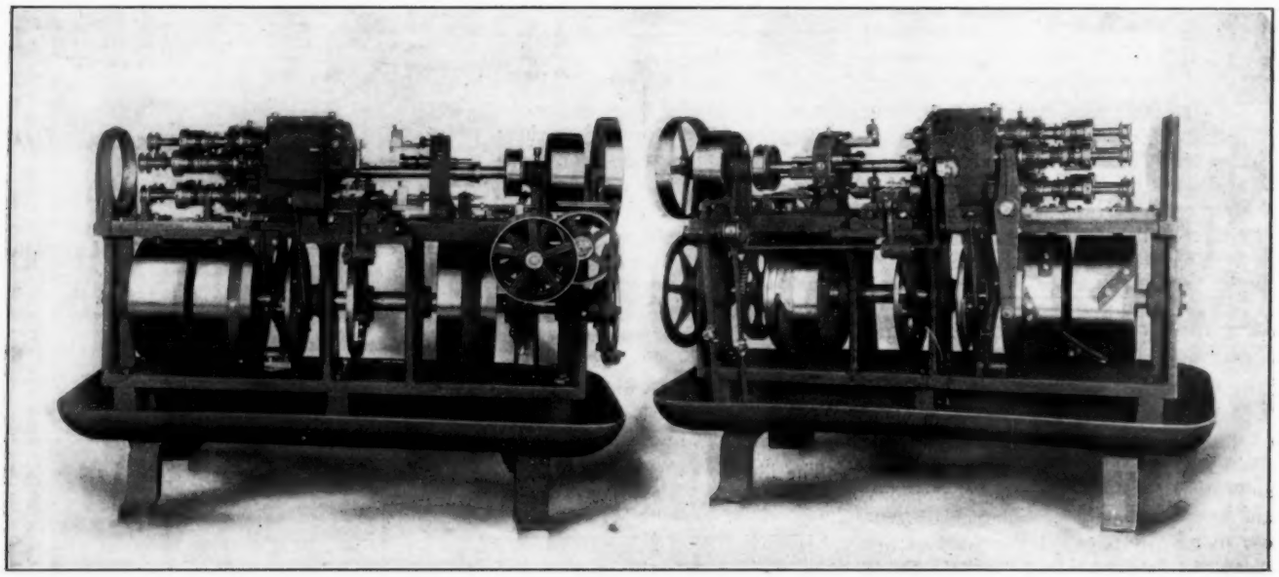


FIG. 1. FRONT AND REAR VIEWS OF AUTOMATIC SCREW MACHINE.

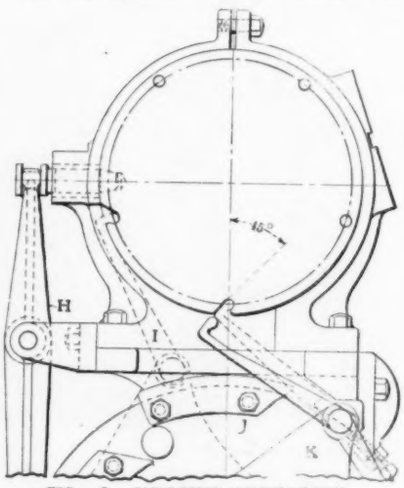


FIG. 3. INDEXING MECHANISM.

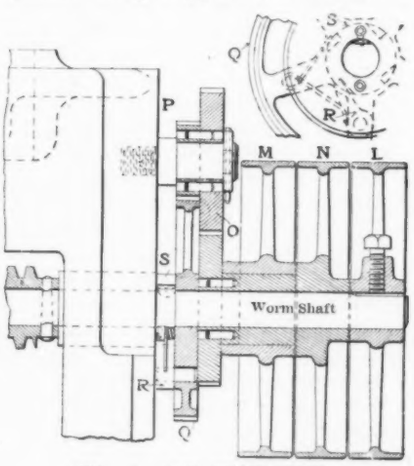


FIG. 4. CAM SHAFT DRIVE.

rectly opposite the locking pin. The different positions of the pawl and the method of stopping the cylinder are indicated by the full and dotted lines. In Fig. 4 is shown the mechanism for driving the cam shaft. Pulley *L* for the fast motion is fastened directly to the worm shaft; pulley *M* is loose; pulley *N* for the cutting speed drives the worm shaft through the change gears *O*, gears *P* and *Q*, pawl *R* and ratchet *S*, the ratchet being keyed to the shaft, and the pawl carried on an arm of gear *Q*. When the belt is on pulley *L* it is obvious that the ratchet will run away from the pawl and the gears need not rotate.

Three cross-slides are used, each of which has an independent motion from the cam disks. A simple slide, Fig. 5, carries the box tools and threading apparatus. The threading device has a spindle *A* which carries the die holder and which is carried in a bushing in No. 4 hole of the slide. In the other end of *A* are a plain pin *B* and spring pin *C*. *D*

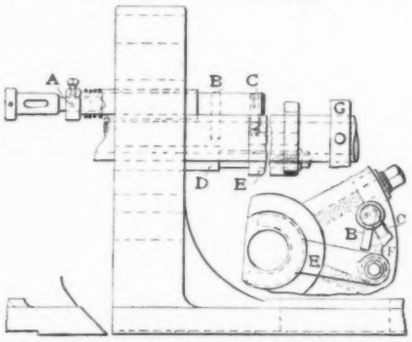


FIG. 5. TOOL SLIDE AND THREADING DEVICE.

is a shoulder stud and upon this slides casting *E* which has a strip of steel *F* riveted to its edge. When the slide is moved forward, the piece to be threaded pushes back the spindle *A* until the die begins to run on. The hub of *E* is up against the shoulder of *D*, but as the die runs on faster than the slide moves, pin *B* runs off from the strip *F*, and the casting is thrown back to the position shown. The bevel of the spring pin *C* allows it to run over *F* until the direction of rotation of the piece is reversed, when this pin engages the other side of the straight edge and the die runs off. The collar *G* is carried on the center sleeve and as the box-tool slide is returned, it pushes *E* (by its forked section) back to the shoulder on stud *D*.

The machine shown has a chuck capacity of ¾ inch and will turn a length of 5 inches. It is built by the Universal Machine Screw Company, Hartford, Conn.

A NEW MAGNETIC BRAKE.

A new magnetic brake for electrically driven machinery has been brought out, which is made in sizes ranging from 1 to 100 horse-power, and is designed to be used under the same conditions as the now common band brake, or other type of brake operated by solenoid. This brake consists of a friction case in the shape of a square open box, provided with supporting legs or feet; a cover being provided for the easy inspection of the working parts and a circular opening on the motor side for removing the hub. This case contains the following essential parts: Square stationary friction plates prevented from rotating by studs at four corners of the case and free to move laterally; circular moving plates, supported by and keyed to the hub and free to move laterally. The hub is made of steel with keys cut from the solid, supported by and firmly keyed to the motor shaft. It is provided with an oil slinger to throw oil inside of the case and prevent it from running out at the hub opening. Lubricating oil is placed in the case to a depth of one-half inch below the lowest point of the hub opening. The moving plates dipping into the oil throw it by centrifugal force to the top of the case from whence it drops on to the friction plates, effectually lubricating them. The oil also acts as an agent to carry the heat away from the friction plates and distribute it over the entire surface of the case.

The friction brake is operated by an electro-magnet which is mounted on the studs which prevent the stationary plates from revolving. The coil of this magnet is form wound, thoroughly insulated, and treated with a vacuum and drying impregnating process which practically converts the copper and insulation into a solid mass, thus excluding all moisture from the coil and aiding in the dissipation of the heat. It is claimed that the metal friction plates running in oil give a coefficient of friction which is absolutely constant under all conditions. The constant braking force is applied axially and is balanced within the frame of the brake, allowing no blow or unbalanced stress on the bearings of the motor. The brake is equally effective in either direction of rotation. The breaking force can be readily adjusted by simply screwing in or out the adjusting screw in the center of the spring cover. When the total amount of wear on all plates equals ¼ inch, one new square plate can be placed in the friction case by removing the magnet case and two top studs. The brake is designed and always tested to release on one-half full-load current of motor as a maximum. On account of the large pole area, the brake does not drop back until about one-tenth full-load current, insuring a continued release of brake until the current is entirely cut off. Weather protection is provided for by the coil being entirely enclosed, protecting it from mechanical injury, grounding or short circuiting. The working parts of the brake are also enclosed and waterproof, insuring equally good service under all conditions of weather. All parts are standardized, being machined from jigs permitting interchangeability of parts.

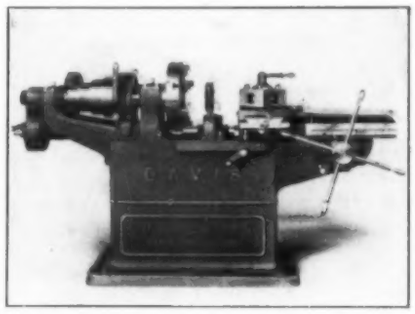
This brake is designed in three forms to meet the service demanded in different classes of electrically driven machinery. It is made by the Electric Controller and Supply Company of Cleveland, Ohio, and is designated by them as their type "Q."

A TURRET-HEAD BORING LATHE.

The illustration shows a turret-head boring lathe with power cross-feed for the turret.

The spindle has a 2-inch hole through it. The front bearing is 4 inches diameter by 6 inches long and the back bearing is 3 inches diameter by 4½ inches long. The cone pulley has four sections for 3-inch belt.

The turret in 12 inches diameter and has six holes 2½ inches diameter. The turret slide is 38 inches long and 14 inches wide. It has a travel of 30 inches on the slide and is provided with power feed, with six instantaneous changes of feed.



A TURRET HEAD BORING LATHE.

An independent, 4-jaw, 18-inch chuck is furnished with each machine. The countershaft has two friction pulleys 12 inches diameter, with 4½-inch face. The weight of the machine complete is 3,200 pounds. This machine is built by the W. P. Davis Machine Company, Rochester, N. Y.

We have received the Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce and Labor for the year ended June 30, 1905. In this are a number of things of interest regarding standards of length, and other matters looked after by the Bureau, and it is evident from it that the Bureau is doing excellent work in the interest of manufactures and the people generally.

Personal.

Mr Robert L. Winkley, of the Publicity Department of the Pope Manufacturing Company, gave an informal talk before the Technical Publicity Association in New York January 18. He gave a good deal of information about methods of advertising automobiles and answered many questions in relation to the matter.

Charles A. Marshall, for twenty-four years with the Russell, Burdsall & Ward Bolt and Nut Works, Portchester, N. Y., has severed his connection with them and entered the service of the Globe Foundry Company, of the same place, where he will have charge of the pattern department.

Charles H. Overkamp, who has been with the American Tool Works Company of Cincinnati, O., for the past nine years as superintendent of their heavy tool department has resigned that position.

Having been in the employ of the Thomas Iron Company, Allentown, Pa., from the day it was founded, Joseph McFetridge has resigned after a service of fifty-one years and nine months. He is the only survivor of the original employees.

E. E. Wood has resigned his position as special sales agent for the Niles-Bement-Pond Company, and has become general manager of the Geo. D. Walcott & Son Machine Company, of Jackson, Mich. Mr. Wood was at one time general superintendent of the Jones & Lamson Machine Company's shops, Springfield, Vt.

Obituary.

William Hutchinson, who built the Keystone Iron Works at Pittsburg, Pa., died a few days since at his home in that city. He was born in Ireland in 1826 and came to this country in 1846.

W. B. Drendar, employed as a locomotive engineer on the Erie Railroad up to four months ago, when he was placed on the pension list, died recently at Meadville, Pa., at the age of eighty one.

Andrew G. Wilson, general manager of the marine department of the Maryland Steel Company, Sparrow's Point, Md., died very suddenly at his home in Wilmington, Del. recently. Mr. Wilson had been for thirty-six years associated with the Harlan & Hollingsworth Company, but went with the Maryland Steel Company, in 1898.

Business Items.

The Robbins Conveying Belt Company has opened an office in the Frick Building Pittsburg. Mr. G. R. Delamater is the Resident Engineer.

The David Bell Engineering Works, Buffalo, N. Y. has recently been incorporated under the same title as before but with increased facilities for the manufacture of steam-hammers and heavy machinery.

The Follansbee Brothers Company of Pittsburg, whose sheet and tin plate works are at Follansbee, W. Va., have decided to erect an open hearth-steel plant adjacent to its works to supply its own requirements.

It is reported that the Federal Cartridge Company, a new $2,000,000 corporation will erect a plant in Norwalk, Conn. F. R. Kingsbury of New Haven, Judge R. Jay Walsh of Greenwich are among the incorporators.

The recent fire in the plant of F. E. Myers & Bro., Ashland, Ohio, was not as serious as was reported, being confined entirely to the storage buildings. The factory and shops are running and deliveries will not be delayed.

The Sprague Electric Company, New York, has been awarded the contract for furnishing complete heating and ventilating apparatus for the U. S. Custom House, New York, and for the Town Hall in Meriden, Conn.

A. E. Hoermann M. E.—261 Broadway, New York, representing Curtis & Co., the Dayton Pneumatic Tool Co., and F. F. Slocomb & Co., has been awarded the contract for the entire pneumatic equipment of the Wire and Telephone Co., of Rome, N. Y.

The S. Obermayer Co. has recently purchased the Foundry Supply factory of H. S. Vrooman, of Chicago. The entire factory of this concern, as well as their stock of merchandise has been moved to the Chicago plant of the S. Obermayer Co., which will fill all orders of this department.

Manufacturers.

The Hess Carriage Company, Hagerstown, Md., will put up an new plant.

The Noble & Wood Machine Company, Troy, N. Y., will enlarge its foundry.

The Iowa Iron Works Company, Centerville, Iowa, will move to Fort Smith, Ark.

The Cincinnati, (Ohio), Roofing and Terra Cotta Company, will erect a $20,000 addition.

The Ritter Dental Manufacturing Company, Rochester, N. Y., will erect a new plant.

The Owensboro, (Ky.), Plaining Mill Company, will erect a new plant to cost $10,000.

The Kalamazoo, (Mich.), Railway Supply Company, will make extensive improvements.

Charles A. Roberson, of Moab, Utah, is back of a scheme to establish a power plant at that place.

The New York Standard Watch Company, Jersey City, N. J., will build a four-story addition.

The American & British Manufacturing Company, Bridgeport, Conn., will erect an addition.

George Bortel, Rochester, N. Y., will put up a plant for the manufacture of clothes washing machines.

The Valdosta, Ga., Sash and Door Company, has started to rebuild its plant, recently destroyed by fire.

The White Star Steam Laundry Company, Cincinnati, Ohio, will erect a four-story addition to its plant

The Baldwin Locomotive Works, Philadelphia, Pa., will build an electric truck shop to cost $100,000.

F. E. Reed Company, glass manufacturers, Rochester, N. Y., will erect a new plant on a much larger scale.

Fire destroyed the mills of the Dunlop Milling Company at Clarksville, Tenn., entailing a loss of $250,000.

The American Woodworking Machine Company, of New York, will build a new factory at its Rochester plant.

The box-board plant of Hon. Louis Payn, at Paynville, N. Y., was burned. Loss, $175,000. It will be rebuilt.

The Western Tube Company, Kewanee, Ill., has let contracts for a new factory building to cost about $200,000.

The Shaw Machine Company, Lowell, Mass., manufacturing textile machinery, will soon begin work on its new foundry.

The Locke Insulator Manufacturing Company, Victor, N. Y., is now having an addition built, at a cost of about $55,000.

The plant of the Altoona, Pa., Glass Works, with the exception of the stock-room, was destroyed by fire. Loss, $30,000.

It is reported that some members of the Retail Merchants' Association of Belleville, Ill., may put up an electric light plant.

The R. M. Cornwell Company, Syracuse, N. Y., is having a new factory built, where it will manufacture its gasolene engines.

The Coulter & McKenzie Machine Company, Bridgeport, Conn., is in the market for latest forge shop equipment.

It is reported that the Kennedy Valve Company, of Coxsackie, N. Y., may locate a branch factory in Lestershire, N. Y.

The Atlantic Coast Line Company, with headquarters in Wilmington, N. C., will erect a million dollar shop at Waycross, Ga.

The American Shipbuilding Company, of Cleveland, Ohio, will rebuild the plant in Bay City, recently destroyed, on a larger scale.

The Weyerhaeuser Timber Company Everett, Wash., will expend about $30,000 in enlarging and installing new machinery in its mill.

Nelson Morris & Company packers will make improvements at their plant at Riverside, Kans. These will include a box factory.

The Abendroth & Root Manufacturing Company, Newburg, N. Y., makers of boilers, pumps, tanks, etc., will erect a new pipe shop.

The Des Moines (Iowa), Stove Repair Company will spend $20,000 in improvements. These will include a new foundry and pattern house.

The Wolverine Motor Company, of Grand Rapids, Mich., is having plans prepared for the construction of a factory in Bridgeport, Conn.

A resolution providing for the issuance of $20,000 worth of bonds for a clear water plant at Manchester, Va., was passed by the Board.

George Broadmore & Son, and Louis Curry, Brighton, Mich., will erect a factory for the manufactue of cabinet and mason levels and other tools.

The Rio Grande Western, it is reported, will replace its shops at Salt Lake City, Utah, recently burned, with a new structure to cost about $60,000.

The Reedy River Power Company has been organized at Laurens, S. C., with a capital of $50,000. N. B. Dial, of Laurens, is president and treasurer.

The Sedro Veneer and Excelsior Company, Sedro-Woolley, Wash., contemplates the erection of a drying system to cost in the neighborhood of $8,000.

The Miller Specialty Company, North Tonawanda, N. Y., will build a new plant and will employ about 100 machinists and draftsmen, when completed.

Fire destroyed the building and machinery of the National Hydraulic Stone Company, Baltimore, Md., causing a loss of $26,000. The plant will be rebuilt.

The Van Wagoner Hardware Company, Cleveland, Ohio, will move to Lima, where it will engage also in the manufacture of cold pressed steel nuts and bolts.

Kellam & Shaffer, Schenectady, N. Y., are putting up a plant to be equipped with the latest machinery for cutting and trimming stone and travelling crane of 15 tons capacity.

Spindler & Deringer, manufacturers of iron and bracework, Jersey City, N. J., are erecting a new plant and will, it is understood, also manufacture scroll and ornamental iron work.

Leopold Iwansky, a capitalist of Parral, Mexico, and several Pittsburg, Pa., men, have formed a syndicate with a paid up capital of $10,000,000 to erect a large electric plant near Parral.

The American Automatic Telephone Company, of Rochester, N. Y., has been incorporated with a capital of $1,500,000 to manufacture an automatic telephone exchange invented by J. W. Lattig, 15 Argyle St., Rochester, and C. L. Goodrum of Athens, Ga. Mr. Lattig is one of the directors.

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat free. E. B. Smith, Columbia, Pa.

Cox Computers, 75 Broad st, New York.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Light and fine mach'y to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Wanted—Two or three second-hand Potter & Johnston Automatic Turret Lathes in good condition. Box 102, AMERICAN MACH.

Want to buy September 3, 1903, and November 26, 1903, issues of AMERICAN MACHINIST, Box 93, AMERICAN MACHINIST.

Andorn & Martin, consulting engineers, will develop your ideas, put your inventions into marketable shape. 25 West 15th st., N. Y. city.

Work wanted for a Cleveland automatic lathe; handles 2 in. and under. The Earle Gear and Machine Co., 141 Oxford st., Philadelphia.

Wanted—Correspondence with large established manufacturing concern in the market for a profitable business. Box 51, AM. MACH.

Fine machinery tools and dies, built to order; experimental work a specialty. Northwestern Machine & Tool Co., 614 Union Trust Bldg., Detroit, Mich.

Clock work and intricate mechanical instruments; meter counters, water, gas or electric; recording devices; special movements to order. D. S. Plumb, 57 E. Park st., Newark, N. J.

Wanted.—Good live agents all over country to sell our make of cranes; also all classes of tramways; we erect complete; those having established trade desired. Yeo Bros., Philadelphia, Pa.

Tool Catalogue No. 22. 950 pages, bound in cloth. Greatest small tool catalogue ever published. Will be sent post-paid on receipt of $1. Money paid for catalogue refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton st., New York City.

For Sale.

For Sale—One No. 1 Bardons & Oliver screw machine, nearly new. Brown Machine Co., Ltd., Battle Creek, Mich.

For Sale—Small machine shop in thriving N. E. village. Good opening for man wih small capital. Box 26, AMERICAN MACHIHIST.

For Sale—10-ton crane, 40 ft. span, rope drive; has been tested to 20 tons; very low price for cash. Address Murray Iron Works Co., Burlington, Iowa.

For Sale—Entire plant of Philadelphia's best known Tamashanta Mill; machinery in perfect order and ready to operate; bankrupt sale; machinery, good will and office furniture will be sold at a sacrifice; immediate possession can be given. Edward M. Bernsteln, Attorney, 299 Broadway, New York city.

Business Opportunities.

Concern that is prepared to make changes in stock clock movements in quantities to adapt to standard specialty; must be in position to take up at once and make prompt delivery. Box 115, AMERICAN MACHINIST.

Advertiser desires a partner with $25,000 to undertake the manufacture of a line of metal specialties on contract. Am thoroughly familiar with the manufacturing and selling end, and wish to combine my knowledge with your money. A splendid opportunity is open to establish a good business. Box 106, AMERICAN MACHINIST.

Wants.

Situation and Help Advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded; but replies will not be returned. If not forwarded they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted.

Classification indicates present address of advertiser, nothing else.

CANADA.

A thorough, practical foundryman, well up in modern foundry practice and cupola management, and competent of taking full charge of foundry in all its details, solicits correspondence with a view to changing. Box 99, AMERICAN MACHINIST.

CONNECTICUT.

Visible typewriting expert, 34, now holding responsible position, competent in all branches of the business, designer, inventor; wants to make a change. Box 70, AM MACH.

IOWA.

Wanted—Position as superintendent and interest in manufacturing business, making small articles in metal. Now holding responsible position. Box 98, AMERICAN MACH.

MASSACHUSETTS.

Situation Wanted; by engineer, first-class license, American, married, 35 years of age. Strictly temperate and steady. Have had charge of factory, office building, electric light and power plants; expert with indicator and elevators, etc. C. Camber, AMERICAN MACH.

MICHIGAN.

Wanted—Position as superintendent by a hustler. Systematic, but no red tape; good executive and mechanical ability in shop and foundry. Can make good. Box 94, AM. M.

NEW HAMPSHIRE.

Wanted—Situation by a blacksmith, who is a first-class tool dresser and steel worker. Box 108, AMERICAN MACHINIST.

NEW JERSEY.

Experienced mechanical draftsman, graduate, wants to better himself; A1 references. Box 113, AMERICAN MACHINIST.

Young man, practical machinist, familiar with small, fine work; experienced in electrical work. Box 89, AMERICAN MACHINIST.

Mechanical draftsman, graduate, several years' experience as designer on pumping engines and condensers, desires change. Box 104, AMERICAN MACHINIST.

Experienced pattern foreman, of good executive ability, at present employed, desires to make a change. Practical and up-to-date on all kinds of work. Box 61, AM. MACH.

Engineering designer seeks position; Corliss engines, pumping and blowing engines, gas engines, power stations. American, extensive experience, inventive, accurate, good habits; competent to take charge. Box 88, AMMERICAN MACHINIST.

NEW YORK.

Mechanical draftsman wishes to change; 4 years' experience. Box 105, AMER. MACH.

Position as superintendent or manager by man with clean record; good business, mechanical and executive abilities; reference. Box 258, Fishkill-on-Hudson, N. Y.

Manager's assistant, purchasing agent, correspondent, systematizer, etc.; 12 years manufacturing experience; mechanical and electrical. Box 114, AMERICAN MACHINIST.

General foreman, 36, successful in handling men and work to best advantage, varied experience in high grade machinery. Expert machinist. Box 23, AMERICAN MACHINIST.

Experienced machinist and draftsman, technical training, now employed in shop, wants shop position where cost reducing design and inventive ability will count. Box 112, AM. M.

Situation wanted by young man with experience in selling and demonstrating machinery. Also conversant with shop and office work. Box 95, AMERICAN MACHINIST.

Technical college graduate, 24, desires position. Practical experience in mechanical drafting work, and with an engineering contractor. Box 90, AMERICAN MACHINIST.

Mechanical draftsman. A first-class toolmaker, with experience as foreman, and now on salary as designer of special machinery jigs, tools, compound and sub-press dies, desires change. Box 111, AMERICAN MACH.

Position as foreman pattern-maker over wood and metal departments; can produce quick work with good results; have had successful experience on plate work for moulding machines. Box 100, AMER. MACH.

Master Mechanic, chief engineer, or first-class executive position; thoroughly understands engines, boilers, dynamos, manufacturing machinery, etc. Assume full responsibility; first-class mechanical engineer. A1 references. Box 50, AMERICAN MACH.

Superintendent—Hustling, aggressive, economical; will raise plant to highest point of efficiency; proficient in speeding help, organizing facilities and producing highest grade of work at lowest cost; expert at tools, dies, fixtures, drafting; accurate estimator and rate fixer; past record will convince before closing. Box 110, AMERICAN MACHINIST.

PENNSYLVANIA.

Draftsman, with 9 years' experience on steam, gas and power engines desires position. Box 109, AMERICAN MACHINIST.

Position wanted—Mechanical draftsman, technical graduate, now employed, wishes to change; 2 years' drafting and 3 years' shop and foundry experience; young man, single, good worker. Box 101, AMERICAN MACH.

Help Wanted.

Classification indicates present address of advertiser, nothing else.

CANADA.

Wanted—Thoroughly experienced foreman for malleable work; none but first-class man need apply. State wages and give references. Box 96, AMERICAN MACHINIST.

Wanted—Two competent draftsmen thoroughly experienced in design of coal handling machinery. State education, experience and salary required. Box 63, AMER. MACH.

Wanted—A mechanical engineer thoroughly experienced in design, repair, and maintenance of bridge shop machinery. Shop has capacity of 18,000 tons per annum. State age, education, experience and salary required. Box 64. AMERICAN MACHINIST.

CONNECTICUT.

Wanted—Foreman for a machine shop employing 20 hands, making small varied parts. Knowledge of drawing and estimating essential. State age, experience and wages wanted. Married man preferred. Box 48, AM. MACH.

ILLINOIS.

Wanted—Independent draftsman on machinery design. Cooke, 1208 Monadnock, Chicago, Ill.

Draftsman—We have positions now open for draftsmen. Call or address Western Electric Co., Chicago, Ill.

Wanted—Draftsmen—Men accustomed to interchangeable work on small tools, jigs and fixtures. Western Electric Company, Chicago., Ill.

Wanted—3 draftsmen on jigs, dies and fixtures. Good experience on small work required. Steady work in Chicago. Engineering Agency, Dept. E, Monadnock Bldg., Chicago.

Wanted—2 experienced detailers on machine tools, and 3 first-class designers on jigs, dies and special machinery. Permanent positions with large firm in Western Pennsylvania. Engineering Agency, Dept. E. Monadnock Bldg., Chicago.

Turret lathe man—Experienced man on heavy turret lathes to take charge of department. Must have had experience in similar position. State experience fully; whether married or single. This position presents a good opportunity for the right man. Address Box 97, AMERICAN MACHINIST.

Wanted—Designer thoroughly experienced in the design of small, accurate, automatic machinery, and with ability to design and develop such machinery. With young growing concern. Excellent opportunity for right man. In replying state age, experience and references; also state salary wanted. Box 53, AMERICAN MACHINIST.

MARYLAND.

Wanted—To meet our constantly increasing requirements, we invite applications from first class tool makers, machinists, Jones & Lamson operators, Gisholt machine operators, milling machines, bench hands and pattern makers. Box 6P, AMERICAN MACHINIST.

MASSACHUSETTS.

Machinists Wanted—We are increasing our force and need good all-round men for the building of special automatic machinery and jobbing. References as to character and ability required. Apply to L. F. Fales, Walpole, Mass.

MICHIGAN.

Wanted—A first-class outside erector, expereinced on electric traveling crane work. Must be able to take full charge of the job and show results. Box 58, AMERICAN MACHINIST.

Wanted—3 or 4 first-class, A1 automatic screw machine hands; to experienced men will guarantee steady position and highest rate of wages. Answer with reference, to Box 85, Detroit, Mich.

MISSOURI.

Wanted—A jig and tool maker on gas engine work. State experience and salary expected. Witte Iron Works Co., Kan. City, Mo.

Wanted—Superintendent for a Missouri gas engine factory employing 50 hands. No foundry. Sizes made from 2 to 50 H. P. Good salary. Do not apply unless able to handle entire mechanical duties. An experienced

executive wanted. No designing or changes. If found satisfactory, some stock for sale guaranteed to earn 25% per annum. Box 62, AMERICAN MACHINIST.

NEW JERSEY.

Wanted—A first-class mechanical draftsman; state experience and salary wanted. Box 881. AMERICAN MACHINIST.

Lathe, planer and boring mill operators wanted for night shift; those accustomed to machine tool work preferred; steady work and good pay to good men. Address the Pond Machine Tool Co., Plainfield, N. J.

NEW YORK.

Wanted—Draftsmen for jigs, fixtures, dies and shop tools. Apply to Mergenthaler Linotype Co., Brooklyn, N. Y.

Wanted—Mechanical draftsman. State age nationality, experience and salary wanted. Box 116, AMERICAN MACHINIST.

Wanted—Two or three first-class lathe hands; also one vertical milling machine man. Steady work and highest wages to good men. Box 77, AMERICAN MACHINIST.

Wanted—Draftsman capable of designing small tools. Must be familiar with punch press work. State experience and salary expected. Box 107, AMERICAN MACHINIST.

Wanted—Experienced draftsmen, first-class machinists, toolmakers and gage makers; give detailed experience, references, age and wages expected. Remington Arms Company, Ilion, N. Y.

Wanted—Foreman for planing and milling machine department. Must be capable of getting best results from up-to-date tools. State age, past experience and wages expected. Box 86, AMERICAN MACHINIST.

Wanted—Strictly first-class foreman for steel car plant. Must have all-around ability of mechanic. Not over 35 years of age; familiar with keeping costs, controlling men and a hustler. Box 54, AMERICAN MACH.

Foundry foreman wanted in large manufacturing establishment; liberal wages will be paid for thoroughly up-to-date, efficient man. Address, with full details and references. "Foundry," AMERICAN MACH.

Cost clerk wanted for moderate size manufacturing plant, making light, interchangeable machinery. Pleasant location. Write giving age, full experience in this line of work, and salary expected. J. M. M., AM. M.

Wanted—Foreman for the lathe department. Young man who has had experience on light and heavy accurate work. Must be capable of handling 75 men. State age, past experience and wages expected. Box 85, AM.M.

Wanted—Factory stores clerk; must be energetic and familiar with all supplies and materials used in the manufacture of firearms; give detailed experience, age, references and salary expected. Remington Arms Company, Ilion, N. Y.

Wanted.—Five detail draftsmen with at least two years' drafting experience, for position with reliable firm in New York City. Previous experience in our line not essential. State age, nationality and salary. "Drafting," AMERICAN MACHINIST.

Wanted—Tool makers; foremen; machinists; instrument assemblers for good positions and steady employment at good pay. none but first-class men need apply. Address General Railway Signal Co., 1738 Elmwood av., Buffalo, N. Y.

Wanted—By large manufacturing concern, competent man to take charge of inspection of small interchangeable parts. Must have practical shop experience. (Fire-arms preferred.) Give experience in detail, age, references and salary expected. Box 71, AM. M.

Wanted—Man of practical experience in the manufacture of small, interchangeable parts; gun work preferred; qualified to estimate on piece prices; must have good executive ability and judgment; state experience and salary expected. Box 926, AM. MACH.

Wanted—Man with technical training as draftsman and engineer, with experience in the design of special machine tools for economical production of interchangeable machine parts in large quantity; person with practical experience as a machinist preferred. Box 953, AMERICAN MACHINIST.

Wanted—Foreman to take charge of small machine shop in New York City, with manufacturing concern building machines for its own use exclusively. Must be thoroughly up in modern machine methods, systematic and able to get work out at least cost consistent with care and accuracy. Steady position for intelligent, capable and reliable man. None others need apply. Write, stating previous experience, wages and references. Box 87.

OHIO.

Wanted—Good live, energetic man, to act as foreman in Ice Machine Shop. Address H. A. N., Box 103, AMERICAN MACHINIST.

Wanted—Three or four first-class operators on Cleveland Automatic machines by a concern near Cleveland. Box 84, AM. MACH.

Wanted—Designer and draftsman for punch presses, power squaring shears and drop hammers. Box 92, AMERICAN MACH.

Draftsmen Wanted.—Two or three first-class draftsmen, familiar with heavy engine design. Apply or address The William Tod Co., Youngstown, Ohio.

PENNSYLVANIA.

Wanted—High-grade erecting machinists for air compressor work.—The Blaidsdell Machinery Co., Bradford, Pa.

Wanted—High-class machinists and toolmakers. Good wages. No labor troubles. Box 41, AMERICAN MACHINIST.

Wanted—Fitters, machine hands and erectors on Corliss Engine work. Scottdale Foundry & Machine Co., Scottdale, Pa.

Wanted—A number of A1 tool, die and instrument makers. Also wood pattern makers. Address Employment Department, Westinghouse Electric & Manufacturing Co., East Pittsburg, Pa.

Wanted—Technically educated engineer having had experience in such work, to take charge of Engineering Department of a concern making gasolene automobiles. State age, experience, references and approximate terms. Address, Box 91, AM. MACH.

WISCONSIN.

To meet our constantly increasing requirements, we invite applications from first-class machinists and bench hands. Those familiar with engine work preferred. Address with references, Globe Iron Works Company, Menomonie, Wisconsin.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen, with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AM. M.

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See Roller Bearings

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Wallace Supply Co., Chicago, Ill.

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Blocks, Chain
See Hoists, Hand.

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National-Acme Mfg. Co., Cleveland, O.

Bone for Case-Hardening
Rogers & Hubbard Co., Middletown, Conn.

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American School of Correspondence, Chicago, Ill.
Audel & Co., Theo., New York.
Henley Pub. Co., Norman W., New York.
Hill Pub. Co., New York.
Modern Machy. Publishing Co., Chicago, Ill.
Turley, Harvey C. & Co., St. Louis, Mo.
Wiley & Sons, Jno., New York.

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Ridgway Dynamo & Engine Co., Ridgway, Pa.
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Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

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Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Betts Mach. Co., Wilmington, Del.
Binsse Mach. Co., Newark, N. J.
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Detrick & Harvey Mach. Co., Baltimore, Md.
Fitchburg Machine Works, Fitchburg, Mass.
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McCabe, J. J., New York.
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Ridgway Mach. & Tool So., Ridgway, Pa.
Vandyck Churchill Co., New York.
Warner & Swasey Co., Cleveland, Ohio.

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Armstrong Bros. Tool Co., Chicago, Ill.

Boxes, Tote
Lyon Metallic Mfg. Co., Chicago, Ill.

Brackets, Lamp
Standard Welding Co., Cleve., O.

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Prentiss Tool & Supply Co., New York.

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Armstrong Bros. Tool Co., Chicago, Ill.
Montgomery & Co., New York.
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Athol Machine Co., Athol, Mass.
Mass. Tool Co., Greenfield, Mass.
Montgomery & Co., New York.
Starrett Co., L. S., Athol, Mass.

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Boston Gear Works, Boston, Mass.

Carborundum
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Phosphor Bronze Smelting Co., Philadelphia, Pa.

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Steffey Mfg. Co., Phila., Pa.

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Kent & Co., Edwin R., Chicago, Ill.
Witteman & Co., A. P., Phila., Pa.

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Clark Cast Steel Cement Co., Shelton, Conn.

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Hendey Mach. Co., Torrington, Conn.
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National Machine Co., Hartford, Conn.
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Whiton Machine Co., D. E., New London, Conn.

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Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

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Cullman Wheel Co., Chicago, Ill.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Jeffrey Mfg. Co., The Columbus, Ohio.
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Morse Chain Co., Trumansburg, N. Y.
Whitney Mfg. Co., Hartford, Ct.

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Hammacher, Schlemmer & Co., New York.
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Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

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Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Ct.
Goodell-Pratt Co., Greenfield, Mass.
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Jacobs Mfg. Co., Hartford, Conn.
Modern Tool Co., Erie, Pa.
Montgomery & Co., New York.
Morse Twist Drill & Mach Co., New Bedford, Mass.
Niles-Bement-Pond Co.,New York.
Oneida National Chuck Co., Oneida, N. Y.
Pratt Chuck Co., Frankfort, N. Y.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Westcott, Chuck Co, Oneida, N. Y.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co, Greenfield, Mass

Chucks, Lathe
Cushman Chuck Co., Hartford, Conn.
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Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg Co., New Haven, Conn.
Horton & Son Co., The E., Windsor Locks, Conn.
Niles-Bement-Pond Co., New York.
Oneida National Chuck Co., Oneida, N. Y.
Skinner Chuck Co., New Britain, Conn.
Westcott Chuck Co., Oneida, N. Y.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Magnetic
Walker & Co., O. S., Worcester, Mass.

Chucks, Planer
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Walker & Co., O. S., Worcester, Mass.
Westcott Chuck Co., Oneida, N. Y.

Chucks, Split
Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.
Westcott Chuck Co., Oneida, N. Y.

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Crocker-Wheeler Co., Ampere, N. Y.
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Stanley G. I. Elec Mfg. Co., Pittsfield, Mass
Switchboard Equipment Co., Bethlehem, Pa.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

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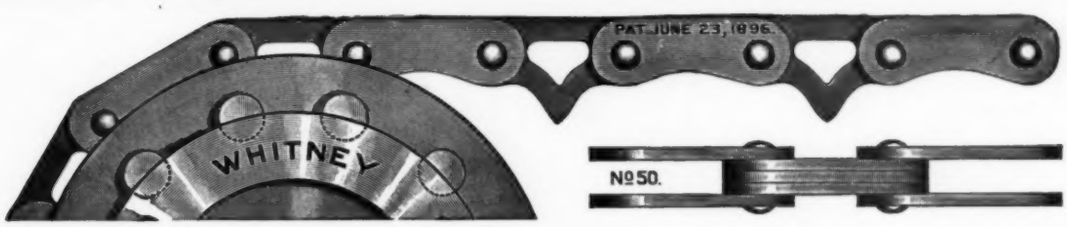
Billings & Spencer Co., Hartford, Conn.

Clutches, Friction
American Tool & Machine Co., Boston, Mass.
Caldwell, Son & Co., H. W., Chicago, Ill.
Cresson Co., Geo. V., Phila, Pa.
Eastern Machinery Co., New Haven, Conn.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Engineering Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., N. Y.
Reeves Pulley Co., Columbus, Ind.
Wood's Sons, T. B., Chambersburg, Pa.

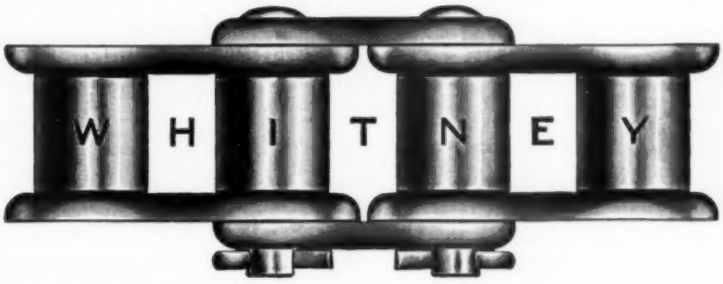
Clutches, Magnetic and Electrical
Cutler-Hammer Clutch Co., Milwaukee, Wis.

Coal Handling Machinery
Link-Belt Engineering Co., Philadelphia, Pa.

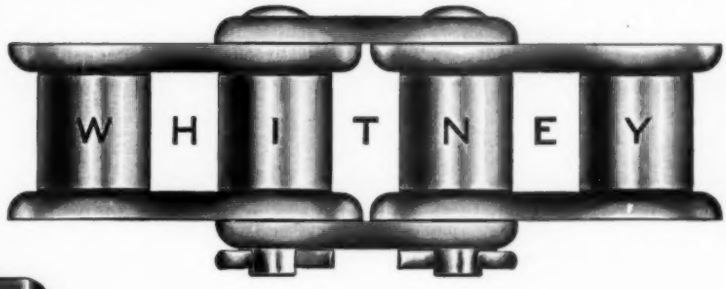
Coils
Standard Welding Co., Cleve., O.



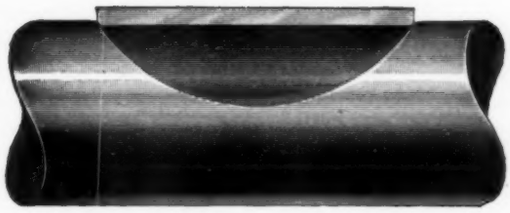
"WIZARD" Chains and Sprockets—Patented



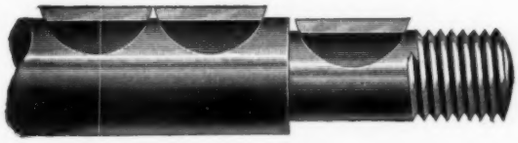
1906 Model "Whitney" Detachable Roller Chains—Patented



Block Chains



"Woodruff" Patent Keys



Three Popular Specialties

"Whitney" Chains
Hand (feed) Milling Machines
The Woodruff Patent System of Keying

THE WHITNEY MFG. COMPANY

HARTFORD, CONN., U.S.A.

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Bury Compressor Co., Erie, Pa.
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Curtis & Co., Mfg. Co., St. Louis, Mo.
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Correspondence Schools
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Veeder Mfg. Co., Hartford, Conn.

Countershafts
Almond Mfg. Co., T. R., Brooklyn, N Y.
Builders' Iron Fdry., Prov., R. I.
LeBlond Mach. Tool Co, R. K., Cincinnati, O.
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing
Cresson Co., Geo. V., Phila., Pa.
Gisholt Mach Co., Madison, Wis.
Reeves Pulley Co., Columbus, Ind.
Speed Changing Pulley Co., Indianapolis, Ind.

Counting and Printing Wheels
Franklin Mfg Co., Syracuse, N. Y.

Coupler, Hose
Ingersoll-Rand Co., New York.

Couplings, Shaft
Almond Mfg. Co., T R., Brooklyn, N. Y.
Caldwell & Son Co, H. W., Chicago, Ill.
Cresson Co., Geo V., Phila., Pa.
Davis Machine Co., W. P., Rochester, N. Y.
Link-Belt Engineering Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkesbarre, Pa.

Couplings, Shaft —*Continued.*
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter Ltd., New York.
Standard Gauge Steel Co., Beaver Falls, Pa.
Woods Sons, T. B., Chambersburg, Pa.

Cranes
Brown Hoisting Mach. Co., New York.
Case Mfg. Co., Columbus, O.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co., Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Maris Bros., Philadelphia, Pa.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Wm., Phila., Pa...
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

Cranes, Portable
Franklin Portable Crane & Hoist Co., Franklin, Pa.
Nicholls, Wm. S., New York.

Crank Pin Turning Machine
Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Crank Shafts
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.
Witteman & Co., A. P., Phila. Pa.

Crucibles
Dixon Crucible Co., Jos., Jersey City, N. J.

Crushers
Ingersoll-Rand Co., New York.
Link-Belt Engineering Co., Philadelphia, Pa.

Cupolas, and Ladles, Foundry
Byram & Co., Inc., Detroit, Mich.
Oberamyer Co., S. Cincinnati, O.
Paxson Co. J. W. Phila., Pa.
Stevens, F B., Detroit, Mich.

Cups and Covers, Oil
Bay State Stamping Works, Worcester, Mass.
Besly & Co. Chas. H., Chicago, Ill.
Elliott Chemical Works, Newton, Mass.
Winkley Co., Detroit, Conn.

Cut Meters
Warner Instrument Co., Beloit, Wis.

Cutters, Milling
Adams Co., Dubuque, Iowa
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Boker & Co., Hermann, New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros., Chicago, Ill.
Ingersoll Milling Mach. Co., Rockford, Ill.
International High Speed Steel Co., New York.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers, John M, Boat, Gauge & Drill Works, Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown &Sharpe Mfg. Co., Providence, R. I.
Burr & Sons, John T., Brooklyn, N. Y.
Davis Machine Co., W. P., Rochester, N. Y.
Fawcus Mach. Co., Pittsburg, Pa.
Hill, Clarke & Co., Boston, Mass.

Cutting-off Machines *Continued*
Hurlburt-Rogers Mach. Co., South Sudbury, Mass.
Newton Machine Tool Works, Philadelphia, Pa.
Nutter, Barnes & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co., New York.

Cutting-off Tools
Armstrong Bros Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Fitchburg Machine Works, Fitchburg, Mass.
Goodell Mfg. Co., Greenfield, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Wesern Tool & Mfg. Co., Springfield, Ohio

Diamond Tools
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York.
Francis & Co., Hartford, Conn.

Dies, Sheet Metal
American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Globe Machine & Stamping Co., Cleveland, Ohio
Kent & Co., Edwin R., Chicago,
Lutter & Gies, Milwaukee Wis.
Niagara Machine & Tool Works, Buffalo, N. Y.
Swaine Co., Fred J., St. Louis, Mo.

Dies, Sub-Press
Risdon, S. A., Waterbury, Conn.
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening
Errington, F. A. New York.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Mch. Co., Springfield, Vt.
Modern Tool Co., Erie, Pa.
Pratt & Whitney Co., Hartford, Conn.
Reliance Mach. & Tool Co., Cleveland, O.
Swaine Co., Fred J., St. Louis, Mo.

Dowel Pins
Winkley Co., Detroit, Mich.

Drawing Boards and Tables
Queen & Co., Phila., Pa.

Drawing Materials
Queen & Co., Phila., Pa.

Draughting Machines
Universal Drafting Mach. Co., Cleveland, O.

Drift Bolt Drivers
Ingersoll-Rand Co., New York.

Drilling Machines, Bench
American Watch Tool Co., Waltham, Mass.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer Worcester, Mass.
Dwight Slate Machine Co., Hartford, Conn.
Goodell-Pratt Co., Greenfield, Mass.
Ingersoll-Rand Co., New York.
McGeorge & Sons, Cleveland, O.
Patterson Tool & Supply Co., Dayton, Ohio.
Pratt & Whitney Co., Hartford, Conn.

Drilling Machines, Boiler
American Tool Wks. Co., Cin., O.
Aurora Tool Works, Aurora, Ind.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drilling Machines, Multiple Spindle
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.

Drilling Machines, Multiple-Spindle—*Continued.*
Barnes Co, W. F. & John Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O
Dwight Slate Machine Co., Hartford, Conn.
Fenn-Sadler Mach. Co., Hartford, Conn.
Foote, Burt & Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Garvin Mach. Co., New York.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Boston, Mass.
Marshall & Huschart Mchy. Co., Chicago, Ill.
McCabe, J. J, New York.
Moline Tool Co., Moline, Ill.
National Machine Co., Hartford, Conn.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Three Rivers Tool Co., Three Rivers, Mich.

Drilling Machines, Portable
Cincinnati Elec. Tool Co., Cin., O.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Stow Mfg. Co., Binghamton, N. Y.

Drilling Machines, Radial
American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Detrick & Harvey Mach. Co., Baltimore, Md.
Dreses Mach. Tool Co., Cin., O.
Fairbanks Co., New York
Fitchburg Machine Works, Fitchburg, Mass.
Foote, Burt & Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
Marshall & Huschart Mach. Co., Chicago, Ill.
McCabe, J J., New York.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co., New York.

Drilling Machines, Turret
Niles-Bement-Pond Co., New York.

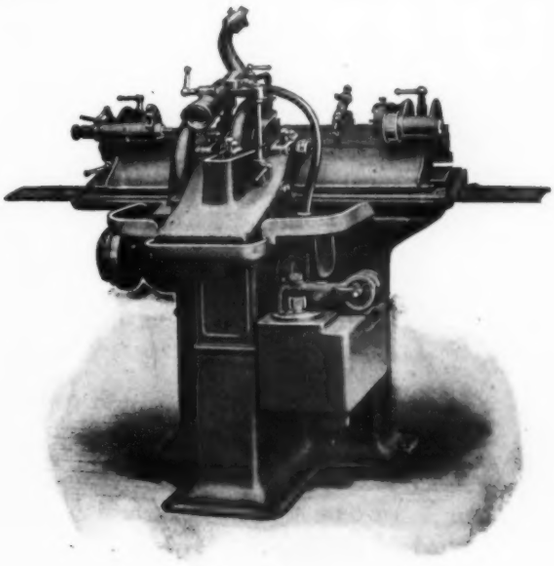
Drilling Machines, Upright
American Tool Wks. Co., Cin., O.
Aurora Tool Works, Aurora, Ind.
Baker Bros., Toledo O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co, W. F & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd, John, Dundas Ont., Canada.
Boynton & Plummer, Worcester, Mass.
Burke Machinery Co., Cleveland, O.
Cincinnati Mach. Tool Co., Cincinnati, O
Davis Machine Co., W. P., Rochester, N. Y.
Dwight Slate Machine Co., Hartford, Conn.
Fairbanks Co., New York.
Fenn-Sadler Mach. Co., Hartford, Conn.
Fosdick Mach Tool Co., Cincinnati, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Knecht Bros. Co., Cincinnati, Ohio.
McCabe, J. J., New York.
Marshall & Huschart Mchry. Co., Chicago, Ill.
Mechanics Mch. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
National Machine Co., Hartford, Conn.

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U.S.A.

The Automatic Cross Feed On Brown & Sharpe Grinding Machines

is advantageous in grinding a large number of pieces accurately to size. The production is increased and the cost of the finished work reduced to a minimum.



FEATURES:

1. Range, .00025" to .004".
2. It forms an integral part of the machine.
3. When work is to size feed is automatically thrown out.
4. Feed can be set to full amount at one end of table travel, or part at one end and part at the other.
5. Mechanism is operated by dogs on front of the table.
6. It is regulated by the simple pressing of a thumb latch which sets the feed for the desired size.
7. Feeding mechanism operates before table reverses.
8. Table can be reversed between the points of travel without feeding the wheel to the work.

Catalog and circulars describe the grinding machines in detail.

Drilling Machines, Upright *Continued*
New Haven Mfg Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson Tool & Supply Co., Dayton, Ohio.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Vandyck Churchill Co., New York.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass
Whitney Mfg. Co., Hartford. Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Drills, Center
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J T., Providence, R. I.
Standard Tool Co., Cleveland, O.

Drills, Hand
Cincinnati Electrical Tool Co., Cincinnati, O.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Pneumatic
Cleveland Pneu. Tool Co., Cleveland, O.
General Pneu. Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
International Steam Pump Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Rail
Foote, Burt & Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O

Drills, Ratchet
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Curtis & Curtis Co., Bridgeport, Conn.
Hisey-Wolf Mach. Co., Cincin., O.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers, Boat, Gauge & Drill Wks., John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock
Ingersoll-Rand Co., New York.
Northern Elec. Mfg. Co, Madison, Wis.

Drills, Spindle
Three Rivers Tool Co., Three Rivers, Mich.

Drying Apparatus
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Dust Collectors
Allington & Curtis Mfg. Co., Saginaw, Mich.

Dynamos
C & C Elecric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
Eck Dynamo & Motor Works, Belleville, N. J.
Electro Dynamic Co., Bayonne, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin, O.
Northern Elec. Mfg Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Roth Bros. Co., Chicago, Ill.
Sprague Elec. Co., New York.
Stanley G. I. Elec. Mfg. Co., Pittsfield, Mass.
Sturtevant Co., B. F, Hyde Park, Mass.
Triumph Elec. Co., Cincin, O.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Dynamotors
Sprague Elec. Co., New York.

Electrical Supplies
Clark, Jr., & Co., Jas., Louisville, Ky.
Cutler-Hammer Clutch Co., Milwaukee, Wis.
Electro Dynamic Co, Bayonne, N. J.
General Elec. Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros, Co., Chicago, Ill.
Sprague Elec. Co., New York.
Stanley G. I. Elec. Mfg. Co., Pittsfield, Mass.
Triumph Elec. Co., Cincinnati, O.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Electrically Driven Tools and Machinery
American Tool Wks. Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, O
Clark, Jr., & Co., Jas., Louisville, Ky.
Crescent Forgings Co., Oakmont, Pa.
Hisey-Wolf Mach. Co., Cincin., O.
Roth Bros. Co., Chicago, Ill.

Elevators
Albro-Clem Elevator Co., Philadelphia, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Harrington, Son & Co,. Edwin, Philadelphia, Pa.
Link-Belt Engineering Co., Philadelphia, Pa.
Morse, Williams & Co., Phila., Pa.

Employment Agency
Engineering Agency, The, Chicago, Ill.

Emery Wheels
See Grinding Wheels.

Emery Wheel Dressers
Desmond-Stephan Mfg. Co., Urbana, O.
Francis & Co., Hartford, Conn.
Heald Machine Co., Worcester, Mass.
International Specialty Co., Detroit, Mich.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.

Enclosures, Tool-room
Merritt & Co., Philadelphia, Pa.

Engineers, Consulting and Mechanical
Dodge & Day, Philadelphia, Pa.
Roedder, O. C., Karlsruhe, Germany.

Engineers, Electrical
Crocker-Wheeler Co., Ampere, N. J.
Dodge & Day, Phila., Pa.

Engines, Automobile
Franklin Mfg. Co., Syracuse, N. Y.
Olds Gasoline Engine Works, Lansing, Mich.
Reeves Pulley Co., Columbus, O.

Engines, Gas and Gasoline
Automatic Mach. Co., Bridgeport, Conn.
Blaisdell Machinery Co., Bradford, Pa.
Brown-Cochran Co., Lorain, O.
Columbus Mach. Co., Columbus, O.
Foos Gas Engine Co., Springfield, Ohio.
Jacobson Mach. & Mfg. Co., Warren, Pa.
Mathews, Hugh, Kansas City, Mo.
Mietz, August, New York.
New Era Engine Co., Dayton Ohio.
Olds Gasoline Engine Wks., Lansing, Mich.
Struthers-Wells Co., Warren, Pa.

Engines, Oil
Mietz, August, New York.

Engines, Steam
American Blower Co., Detroit, Mich.
Buckeye Engine Co., Salem, Ohio.
Buffalo Forge Co., Buffalo, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa
Struthers-Wells Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Engraving Machinery
Gorton Mach. Co., Geo., Racine, Wis.

Engravings
Springfield Photo-Engraving Co., New York.

Exhaust Heads
Sturtevant Co., B. F., Hyde Park, Mass.

Exhibition Machinery
Philadelphia Bourse, Phila., Pa.

Expanders, Boiler Tube
Nicholson & Co., W. H., Wilkesbarre, Pa.

Extinguishers, Fire
Badger & Sons Co., E. B., Boston, Mass.

Fans, Electric
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Elec. Co., New York..
Stanley G. I. Electric Mfg. Co., Pittsfield, Mass.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Fans, Exhaust
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Feathers
Standard Gauge Steel Co., Beaver Falls, Pa.

Files and Rasps
Barnett Co., G & H., Phila., Pa.
Hammacher Schlemmer & Co., New York.
Heller Bros. Co., Newark, N. J.
Montgomery & Co., New York.
Nicholson File Co., Prov., R. I.
Richhelm & Co., E. P., New York.

Filing Machines
Cochrane-Bly. Co., Rochester, N. Y.
Detrick & Harvey Mach. Co., Baltimore, Md.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Henry & Wright Mfg. Co., Hartford, Conn.

Fillets, Leather
Cleveland Fillet Co., Cleveland, O.

Flexible Shafts
Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.
Stow Mfg. Co., Binghamton, N. Y.

Forges
Boynton & Plummer, Worcester, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Buffalo Forge Co., Buffalo, N. Y.
Burke Machinery Co., Cleveland, Ohio.
Miner & Peck Mfg. Co., New Haven, Conn.
Ingersoll-Rand Co., New York.
National Machinery Co., Tiffin, O.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forgings, Drop
Billings & Spencer Co., Hartford, Conn.
Crescent Forgings Co., Oakmont, Pa.
Lang Co., G. R., Cincinnati, Ohio.
Wyman & Gordon, Worcester, Mass.

Forgings, Hydraulic
Wyman & Gordon, Worcester, Mass.

Forgings, Steel
Baldwin Steel Co., New York.
Boker & Co., Hermann, N. Y.
Crescent Forgings Co., Oakmont, Pa.

Forgings, Steel —*Continued.*
Heppenstall Forge & Knife Co., Pittsburg, Pa.
Kent & Co., Edwin R., Chicago, Ill.
McInnes Steel Co., Corry, Pa.
Tindel-Morris Co., Eddystone, Pa.
Witteman & Co., A. P., Phila., Pa.
Wyman & Gordon, Worcester, Mass.

Foundry Furnishings
Adams Co., Dubuque, Iowa.
Byram & Co., Inc., Detroit, Mich.
Ingersoll-Rand Co., New York.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.
Sturtevant Co., B F., Hyde Park, Mass.

Fuel Economizers
Sturtevant Co., B. F., Boston, Mass.

Furnaces, Annealing and Tempering
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Witteman & Co., A. P., Phila., Pa.

Furnaces, Enameling
American Gas Furnace Co., New York.

Furnaces, Forge
Witteman & Co., A. P., Phila., Pa.

Furnaces, Gas
Am. Gas Furnace Co., N. Y. City.
Chicago Flexible Shaft Co., Chicago, Ill.
Westmacott Co., J. M., Providence, R. I.

Furnaces, Melting
American Gas Furnace Co., New York.

Furniture, Machine Shop
Manufacturing Equip. & Engineering Co., E. Boston, Mass.
Merritt & Co., Philadelphia, Pa.
New Britain Mach. Co., New Britain, Conn.

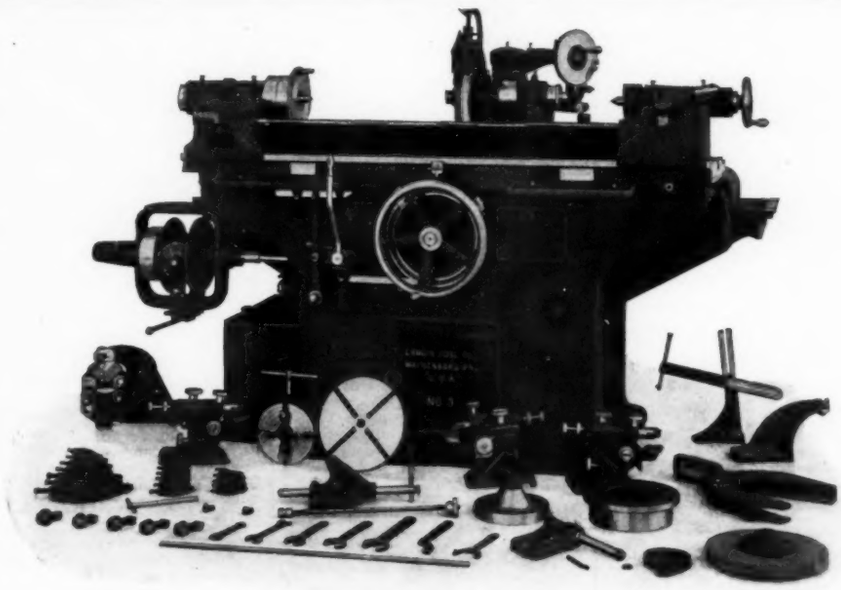
Gas Blowers and Exhausters
Sturtevant Co., B. F., Boston, Mass.

Gauges, Recording
Bristol Co., Waterbury, Conn.

Gauges, Standard
Brown & Sharpe Mfg. Co., Providence, R. I.
Henry & Wright Mfg. Co., Hartford, Conn.
Mass. Tool Co., Greenfield, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers, John M., Boat, Gauge & Drill Works, Gloucester City, N. J.
Slocomb Co., J T., Prov., R. I.
Starrett Co., L S., Athol, Mass.

Gauges, Steam
Davis Machine Co., W. P., Rochester, N. Y.
Lunkenheimer Co., Cincinnati, O.

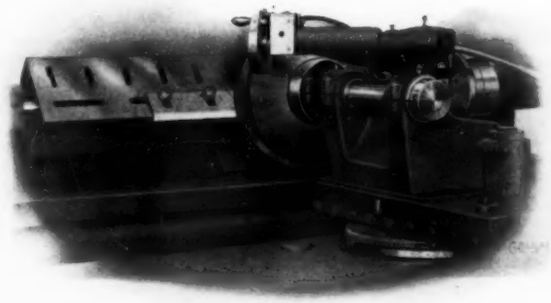
Gear Cutting Machinery
Adams Co., Dubuque, Iowa.
American Watch Tool Co., Waltham, Mass.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Bickford Drill & Tool Co., Cin., O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Dwight Slate Machine Co., Hartford, Conn.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Ganschow, Wm., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Matchless Cigar Lighter Mfg. Co., New York.
Morse, Williams & Co, Phila., Pa.
Newton Mach. Tool Wks., Philadelphia, Pa.



FOR TOOL ROOM GRINDING

If you want a complete universal tool-room grinder the Landis No. 3 Universal will meet your requirements in a highly commendable manner. No machine will better meet the demands for tool-room grinding. At the same time it is a manufacturing tool of rare excellence. Built to withstand the most severe service; produces the highest possible grade of work and does it economically. Possesses all those strong features for which Landis Grinders are noted.

Two Valuable Attachments For Landis Universal Grinders



PLAIN SURFACE AND KNIFE GRINDING ATTACHMENT

A device for converting a cylindrical grinding machine into a surface grinding machine—a useful attachment for tool-room work. It consists of a tilting table which is held on the bed between the centers by a support or bracket for securing same in all positions, from 90 degrees to zero, the circular flange by which it is clamped being graduated. A special grinding wheel head is used in place of the regular wheel head. The grinding is done with the side of a cylindrical wheel which produces a straight surface This attachment is adapted for handling a great variety of work such as shear blades, planer and paper knives, square bars, etc. Provision is made for the free use of water, which is essential in all operations of grinding.

MAGNETIC CHUCK

This is attached to the Universal Machine by screwing on the headstock spindle, taking the place of the regular work-driving face plate. It is driven by a fixed pulley on the spindle which is located back of chuck next to bearing in headstock. This chuck is suitable for handling quite a variety of work, such as grinding the sides of plates, saws, milling cutters, washers, etc. One of its applications is here illustrated.

We are grinding specialists and manufacture a full line of grinding machines, including Universal, Plain, Internal and Crank Grinders. Send for the catalog.

Landis Tool Company, Waynesboro, Pa., U.S.A.

AGENTS—W. E. Flanders, 309 Schofield Building, Cleveland, Ohio. Walter H. Foster Co., 114 Liberty St., New York. C. W. Burton, Griffiths & Co., London. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Paris and Bilbao. A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal, Canada.

Gear Cutting Machinery *Continued*

Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Turley, Harvey G., St. Louis, Mo.
Walcott & Son, Geo. D., Jackson, Mich.
Whiton Machine Co, D. E., New London, Conn.

Gear Testing Machinery

Gisholt Mach. Co., Madison, Wis.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Gears, Cut

Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Wks., Boston Mass.
Brown & Sharpe Mfg Co., Providence, R. I.
Caldwell & Son Co., H. W., Chicago, Ill.
Cresson Co., Geo V., Phila., Pa.
Davis, Rodney, Philadelphia, Pa.
Earle Gear & Mach. Co., Philadelphia, Pa.
Eberhardt Bros. Mach. Co., Newark, N. J.
Eickemeyer Mfg. Co, Yonkers, N. Y.
Fawcus Mch. Co., Pittsburg, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Genschow, Wm., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., The, Cleveland, O.
James, D. O., Chicago, Ill.
Massey Mach. Co., Watertown, N. Y.
Morse, Williams & Co, Phila., Pa.
New Process Raw Hide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Patterson, Gottfried & Hunter, Ltd., New York.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Wks., Cleveland, O.
Simonds Mfg. Co., Pittsburg, Pa.
Syracuse Raw Hide Mfg. Co., Syracuse, N. Y.
Taylor-Wilson Mfg. Co., Allegheny, Pa.
Turley, Harvey G., St. Louis, Mo.
VanDorn & Dutton, Cleveland, O.
Walcott & Son, Geo. D., Jackson, Mich.

Gears, Molded

Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., Syracuse, N. Y.
Greenwald Co., I. & E., Cin., O.
Philadelphia Gear Wks., Philadelphia, Pa.
Taylor-Wilson Mfg. Co., Allegheny, Pa.
Walcott & Son, Geo. D., Jackson, Mich.

Gears, Rawhide

Boston Gear Wks., Boston, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Fawcus Mch. Co., Pittsburg Pa.
Gould & Eberhardt, Newark, N. J.
Horshburg & Scott Co., Cleveland, Ohio.
New Process Raw Hide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Syracuse Raw Hide Co., Syracuse, N. Y.

Gears, Worm

Albro-Clem Elevator Co., Philadelphia, Pa.
Boston Gear Wks., Boston, Mass.
Fawcus Mch. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
James, D. O., Chicago, Ill.
Morse, Williams & Co, Phila., Pa.
Nuttall Co., R D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Simonds Mfg. Co., Pittsburg, Pa.
Taylor-Wilson Mfg. Co., Allegheny, Pa.
VanDorn & Dutton, Cleveland, O.
Walcott & Son, Geo. D., Jackson, Mich.

Generating Sets

Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Elec. Co., New York.
Stanley G. I. Electric Mfg. Co., Pittsfield, Mass.
Sturtevant Co., B. F., Boston, Mass.
Triumph Elec. Co., Cincinnati, O.
VanDorn & Dutton, Cleveland, Ohio.
Walcott & Son, Geo. D., Jackson, Mich.

Generators, Gas

American Gas Furnace Co., New York.

Gibs

Standard Gauge Steel Co., Beaver Falls, Pa.

Graphite

Dixon Crucible Co., Jos., Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Grinders, Automatic Knife

Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.

Grinders, Center

Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.
Heald Mch. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Mueller Mch. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Patterson Tool & Supply Co., Dayton, Ohio.
Rivett-Dock Co., Boston, Mass.
Stow Mfg. Co., Binghamton, N. Y.

Grinders, Cock

Windsor Mach. Co., Windsor, Vt.

Grinders, Cutter

Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Mach. Co., Cincinnati, O.
Crocker-Wheeler Co., Ampere, N. J.
Dayton Machine & Tool Works, Dayton, O.
Garvin Machine Co., New York.
Gould & Eberhardt, Newark, N. J.
Greenfield Mach. Co., Greenfield, Mass.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., New York.
Niles-Bement-Pond Co., New York.
Norton Emery Wheel Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Rivett-Dock Co., Boston, Mass.
Wells & Sons Co., F. E., Greenfield, Mass.

Grinders, Cylindrical

Brown & Sharpe Mfg. Co., Providence, R. I.
Heald Mach. Co., The, Worcester, Mass.
Norton Grinding Co., Worcester, Mass.

Grinders, Disk

Besly & Co., Chas. H., Chicago, Ill.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Diamond Mach. Co., Prov., R. I.
Gardner Machine Co., Beloit, Wis.
Heald Machine Co., Worcester, Mass.
Hill, Clarke & Co., Boston, Mass.
Iroquois Mach. Co., New York.
Patterson Tool & Supply Co., Dayton, Ohio.
Ransom Mfg. Co., Oshkosh, Wis.
Rowbottom Machine Co., Waterbury, Conn.
Safety Emery Wheel Co., Springfield, O.

Grinders, Drill

Heald Mch. Co., Worcester, Mass.
Hill, Clarke & Co., Boston, Mass.
Niles-Bement-Pond Co., New York.
Standard Tool Co., Cleveland, O.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Internal

Brown & Sharpe Mfg. Co, Providence, R. I.
Greenfield Mach. Co., Greenfied, Mass.
Heald Mch. Co., Worcester, Mass.
Wells & Sons Co., F. E., Greenfield, Mass.

Grinders, Piston Ring

Heald Mach. Co, Worcester, Mass.

Grinders, Portable

Cincinnati Electrical Tool Co., Cincinnati, O.
Heald Mach Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.

Grinders, Tool

Armstrong Bros. Tool Co., Chicago, Ill
Barnes Co., W. F. & John, Rockford, Ill.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Electrical Tool Co., Cincinnati, O.
Diamond Mach. Co., Prov., R. I.
Dwight Slate Machine Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Mach. Co., Worcester, Mass.
Hill, Clarke & Co., Boston, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Landis Tool Co., Waynesboro, Pa.
Lutter & Gies, Milwaukee, Wis.
Modern Tool Co., Erie, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Rivett Lathe Mfg. Co., Boston, Mass.
Safety Emery Wheel Co., Springfield, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
Vandyck Churchill Co., New York.
Walker & Co., O S., Worcester, Mass.
Whitney Mfg. Co., Hartford, Ct.

Grinding and Polishing Machines

Barnes Co., W. F. & John, Rockford, Ill.
Besly & Co., Chas. H., Chicago, Ill.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Builders' Iron Foundry, Providence, R. I.
Burke Machinery Co., Cleveland, Ohio.
Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Co., Worcester, Mass.
Crocker-Wheeler Co., Ampere, N. J.
Diamond Mach. Co., Prov., R. I.
Fairbanks Co., New York.
Gilmore Electric Co., South Boston, Mass.
Goodell-Pratt Co., Greenfield, Mass.
Greenfield Mach. Co, Greenfield, Mass.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Machine Co., Cin., O.
Iroquois Mach. Co., New York.
Landis Tool Co., Waynesboro, Pa.
Marshall & Huschart Mchry. Co., Chicago, Ill.
Montgomery & Co., New York.
National Machine Co., Hartford, Conn.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Norton Emery Wheel Co., Worcester, Mass.
Norton Grinding Co., Worcester, Mass.
Patterson Tool & Supply Co., Dayton, O.

Grinding and Polishing Machines —*Continued.*

Prentiss Tool & Supply Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Rivett-Dock Co., Boston, Mass.
Rivett Lathe Mfg. Co., Boston, Mass.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Star Corundum Wheel Co., Detroit, Mich.
Stow Mfg. Co., Binghamton, N. Y.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.
Walker & Co., O. S., Worcester, Mass.
Webster & Perks Tool Co., Springfield, O.
Wells & Sons Co., F. E., Greenfield, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinding Wheels

Abrasive Material Co., Philadelphia, Pa.
Adams Co., Dubuque, Iowa.
Builders' Iron Foundry, Providence, R. I.
Carborundum Co., Niagar Falls, N. Y.
Davis Machine Co., W. P., Rochester, N. Y.
Diamond Mach. Co., Prov., R. I.
Hampden Cor. Wheel Co., Brightwood, Mass.
National Corundum Wheel Co., Buffalo, N. Y.
Niles-Bement-Pond Co., New York.
Norton Emery Wheel Co., Worcester, N. Y.
Safety Emery Wheel Co., Springfield, O.
Star Corundum Wheel Co, Detroit, Mich.
Superior Corundum Wheel Co., Waltham, Mass.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Ct.

Grindstones and Frames

Athol Machine Co., Athol, Mass.
Cleveland Stone Co., Cleveland, Ohio.
Niles-Bement-Pond Co., New York.

Gun Barrel Machinery

Diamond Mach. Co., Prov., R. I.
Pratt & Whitney Co., Hartford, Conn.

Hammers, Drop

Billings & Spencer Co., Hartford, Conn.
Bliss Co., E W., Brooklyn, N. Y.
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Gould & Eberhardt, Newark, N. J.
Merrill Bros., Brooklyn, N. Y.
Miner & Peck Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.

Hammers, Pneumatic

Cleveland Pneu. Tool Co., Cleveland, O.
Ingersoll-Rand Co, New York.
International Steam Pump Co., New York.
Niles-Bement-Pond Co., New York.

Hammers, Power

Bradley & Son, C. C., Syracuse, N. Y.
Fairbanks Co., New York.
Niles-Bement-Pond Co., New York.
Patterson Tool & Supply Co., Dayton, Ohio.
Prentiss Tool & Supply Co., New York.
Scranton & Co., The, New Haven, Conn

Hammers, Steam

Bethlehem Fdry. & Mach. Co., So. Bethlehem, Pa.
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Crescent Forgings Co., Oakmont, Pa.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co., New York.

A Machine Which Prophesies.

BY C. H. CLAUDY.

The title is not fanciful. An engine is in use by the Coast Survey at Washington, D. C., which can and does predict the time of high and low tide for a given locality, and makes these predictions for a year in advance. Its performance is not limited to a year, but that is the maximum of work it is usually called upon to do.

The illustrations show this machine to be compact and delicate, but no illustration can show the complicated mechanism or the delicacy with which it is arranged and adjusted. To make these tidal predictions, which are issued in the form of a fat book of tables every year, by the Survey, the machine is first set, and then operated by hand. As may be surmised, the setting of the machine is the point at which accurate mechanism and the human brain join forces.

Tides are caused, primarily, by the gravity action of moon and sun upon the water covering three-fourths of the earth's surface. Had the sea no bottom, or a bottom of uniform depth; had water no inertia nor viscosity; were there no winds, no streams, no friction—if, in other words, purely theoretical conditions obtained tidal predictions could be made from a knowledge of the astronomical factors only. The contrary is the case however, and a tidal prediction, based on the astronomical factors, must be modified by the configuration of the land, the water flowing from the land, the weather, the character of the sea-bottom, etc., etc. Until this machine was invented, all this work was done by computers. Now, however, nineteen factors of a tide, known for a certain locality, are indicated on the machine, by the setting of nineteen dials with pointers. These pointers when set, so arrange the mechanism that on the turning of a handle, other dials on the front of the machine record the height of the tide, the time it occurs for night and day, etc., etc.

Before going any deeper into this peculiar engine, it may be interesting to know how these nineteen factors are determined. Nineteen elements are not necessary—a dozen will do, but, obviously, the more elements are taken into consideration, the more perfect will the calculation be. In determining the elements of a tide, the first thing which is done is the plotting, in co-ordinate curves of the results of a long series of observations of tides at that particular place. These show the tides as they are. Knowing the astronomical elements, their subtraction will leave all the other causes together, that is, the local causes, the physical causes (inertia, etc.), and the weather. Another long series of observations determined how the tide is affected by the prevailing weather, and this factor is also eliminated. Then allowing for the physical causes, the calculator can determine in what respect the tide is affected by the land configuration, depth of water, etc. Thus selection and exclusion goes on until the tide at this particular station is resolved into its elements, from which any good computer could calculate tides for that spot for an indefinite time to come, subject only to the error of unforseen weather conditions, cyclones, storms, tidal waves, etc.

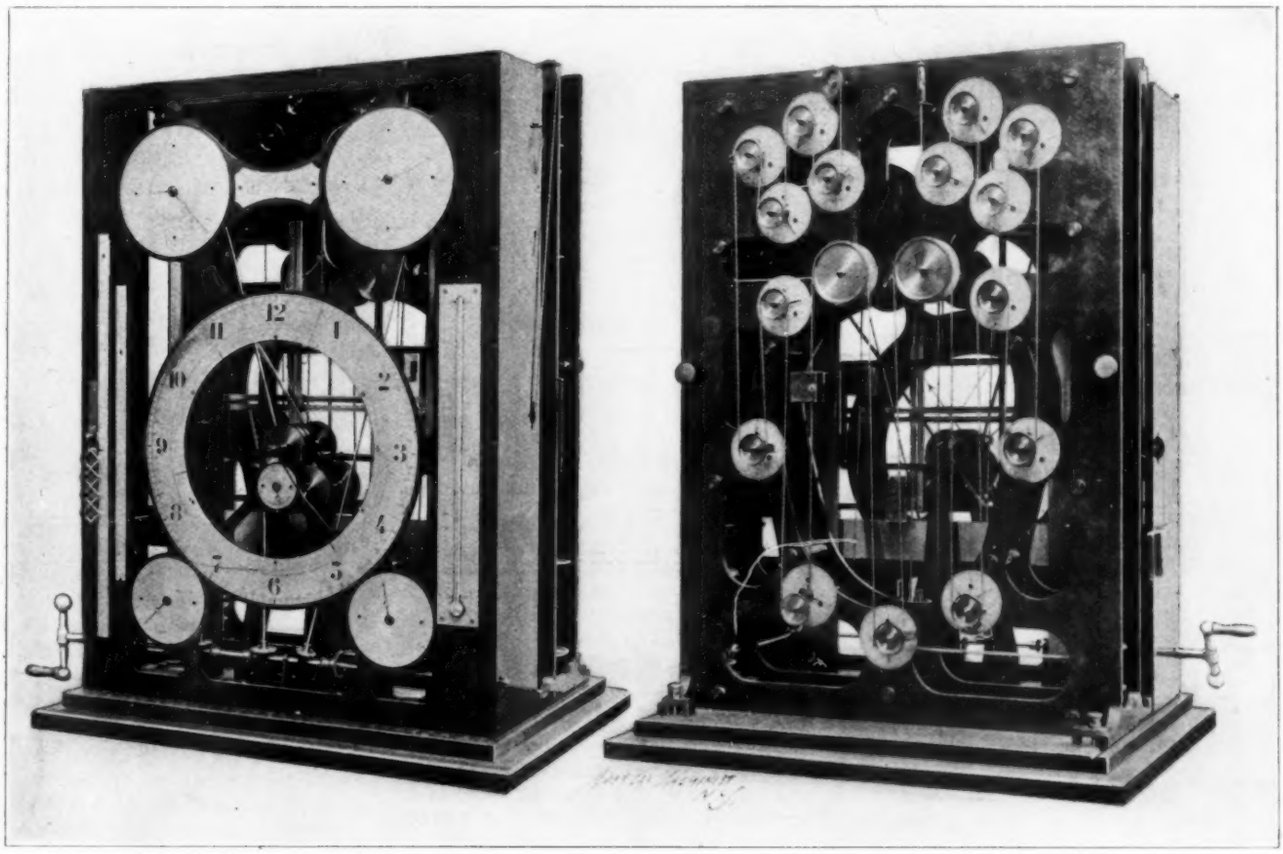


FIG. 1. FRONT VIEW. TIDE COMPUTING MACHINE. FIG. 2. REAR VIEW.

It will be readily seen that each factor alters all the rest. Consequently, the machine which does the predicting must be so constructed that an alteration of one factor will have its effect on the others. Reference to the rear view of the machine will show in a measure how this is done. Each pointer is on a pulley, mounted eccentrically on its shaft, and over this pulley passes a chain, which goes from one to another. Obviously, if the eccentricity of one pulley is altered, it has its proportionate effect on all the rest.

But just how the mechanism operates can not be put into words. It is obvious

that a detailed description of the inner working of a machine like this would require numerous working drawings and pages of description. Yet, complicated as the machine is, it is wonderfully free from error. Lost motion, of course, must be expected and provided for in so complicated a machine, and as far as may be, this is obviated by the greatest nicety of detail in building, everything about the instrument having been made with the most painstaking skill. The greatest error is found to come from torsion in the long shafts, a fault which will be eliminated in the new engine, now building at the Survey. But even with this torsion and lost motion, the machine is much more accurate than a computer, inasmuch as no mental calculation would ever comprise nearly so many factors of a tide as the machine does, because of the complicated mathematics involved and the labor necessary.

The new machine now being built at the Survey, will take into account thirty-nine factors of a tide, instead of nineteen, and will be run by clock-work, instead of by hand. In addition to making the predictions for high and low tide, the new machine will give the state of the tide at any hour desired, and it is hoped that a printing attachment can be added so the results will be printed out, and not require a clerk to make readings and note the predictions as made. If this is accomplished, once the machine is set and started, it will run without attention, making the predictions for as long a time as desired, printing them as made, and it will thus be entirely automatic in action.

The engine was invented by Prof. William Ferrel, who gave the mechanism to the Government without charge for his idea. It cost originally but $3,500 and does the work of forty expert computers.

The English Precision Lathe and the Newall Measuring Machine.

BY JOHN E. SWEET.

I have been greatly interested in two of the machines recently illustrated in the AMERICAN MACHINIST and am led to comment on them because both possess marvelously fine features, and both must from necessity develop defects if used to any extent.

The fact, that the precision lathe shown at page 619, Vol. 28, Part 2, has at such an expense been built and a special room prepared for housing it, implies that the lathe is to be used for making other screws, and that the screws so made shall be practically perfect.

The fact that the nut is in two parts separated at right angles with the center line of the screw, and means provided to move one half toward or from the other, implies that there was originally lost motion in the nut, or that the screw is expected to wear as it is sure to do if the lathe is used, and if it is not to be used it need never have been made. Assuming it to be used and to wear, then accurate screws cannot be produced except by always cutting screws of approximately the same length as the master screw, or say from 34 to 36 inches in length, the master screw being assumed to be 3 feet long.

Bearing in mind that the nut is in two parts, one part wearing against one side of the square thread *A*, Fig. 1, driving forward the carriage and controlling the cutting tool, that part of the nut must over-run the master screw at each end about one-half its length, the result of which will be that the other half of the nut *B*, Fig. 2, will run off the screw at the last part of the cut, allowing the tool to jump ahead an amount equal to the slack in the other half of the nut on the screw. As it is stated that the lathe is to be used only to correct screws that have already been roughed out by other means, the inclination to jump ahead will be worse than if no previous work had been done.

If the lathe is used on shorter work or if the driving half of the nut is not made to run off each end of the master screw, then the screw will wear out of pitch from the very start.

Where the limit of error is down to the fifty thousandth of an inch, the unequal wear of one fifty thousandth of an inch will double the error. In designing the machine, a mistake was made in not parting the nut longitudinally.

While the precision lathe will only cut

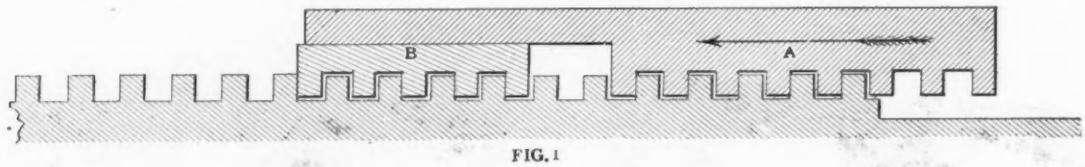


FIG. 1

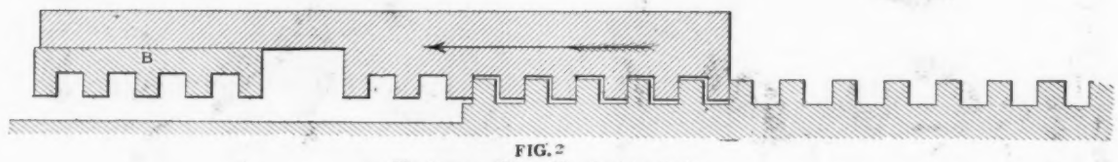


FIG. 2
The Screw and Nut of the Precision Lathe

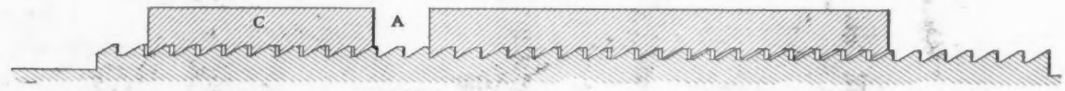


FIG. 3

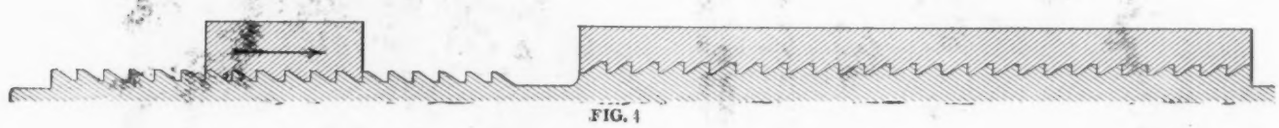


FIG. 4

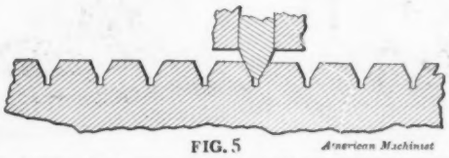


FIG. 5 *American Machinist*

THE SCREW AND NUT OF THE MEASURING MACHINE.

screws of its own pitch, the design must be to in some way utilize it for producing screws of other pitches and of at least approximate accuracy.

This may be done by cutting a long screw into short pieces and using these pieces for master screws for cutting screws of their own length. In this way it would seem as if the screw of the measuring machine, shown at page 734, Vol. 28, Part 2, ought to be produced sufficiently accurate without the ingenious correcting device resorted to for correcting the error. Otherwise, why go to the expense of the precision lathe? When this correction is necessary, the plan adopted in the Newall machine is a long way superior to anything I have seen before, and while it is only a modification of that used in the Cornell measuring machine of 1873, it is just one of those things that make a good idea practical. The ratchet thread too was in the Cornell machine, but in the Newall machine they have added what seems to me a purely unnecessary device that will spoil the whole business, and that is the second nut on the same thread with a spring to make up lost motion.

In the use of the machine for end measure only, there is no necessity for taking up wear, as very little wear will come on the square face of the thread, but with this spring nut always crowding against the square face of the thread it must wear and, as a part of the thread does not enter the main nut at all, as at *A*, Fig. 3, the result cannot be otherwise than a constant change of pitch. Although the check-nut *C* will overun the part *A*, that only wears off the bevel surface and in no way helps to maintain constant pitch. This could be avoided in two ways—by parting the nut longitudinally as suggested in the case of the precision lathe, having each half of the length of the screw, or by cutting away the thread so as to have its surface only as long as the main nut and having the chuck-nut on a separate section as shown in Fig. 4.

When using line measures it is likely advisable to prevent lost motion in some way and for this and for a graduating engine I believe a V-thread the right way, and any sort of a nut, even a single knife edge if only held in contact will do, and this will do for working all lengths.

The work to move the carriage being alike in both directions, wear will take place equally on each side of the thread, and while wear will change the diameter of the master screw it will not change the pitch. See Fig. 5. Such a screw may rest in a trough and thus eliminate the sag and the errors in the screw can be eliminated by scraping the sides of the thread and this will give the same length of surface to correct the errors as the plan used in the Newall machine, and avoid all intervening mechanism.

Investigations and Commercial Tests in Connection with the Work of an Engineering College.

BY PROF. D. S. JACOBUS.*

In any school it is necessary, in securing the best efficiency in instruction, that the professors shall be able to speak with authority on the subjects which they teach. In technical schools those who teach the practical engineering subjects cannot speak with authority unless they have had practical experience. Investigations and commercial tests may serve to give them this practical experience, and the question naturally arises; is it a good policy for professors to conduct such work in connection with their regular college duties?

Let us consider the various ways in which a professor in an engineering school may acquire the practical experience which is necessary in his work.

First, he may be called to a professorship from the practical field.

Second, after first teaching for a time and finding how necessary a practical experience is in his work, he may turn to the practical field, and then return to teaching.

Third, he may undertake practical work in connection with his college duties, and gain his experience in this way.

Each method possesses its own advantages and disadvantages. Starting with the first, it must be admitted that many of our best instructors have entered the teaching line after they have had experience in the practical field. Such a man has an advantage in being able to make use of this experience immediately when he starts in at his teaching work. There is a disadvantage however in the fact that should he have secured a mature experience in the practical field, he will necessarily be no longer a young man, and it may be hard for him to teach and to properly adapt himself to the theoretical part of his course. Again, if he has made a marked success in the practical field his pecuniary reward may be so great that he would have to make a considerable sacrifice in this respect should he turn to teaching. There are some men who, from their love of teaching or through the influence of high ideals, have been willing to do this, but these are few, and the college obtaining such a man is indeed fortunate. This side of the problem is a serious one from the standpoint of the college, because the man they would like to get may be beyond their reach, and those available may have made only a partial success in the practical field.

If a young man with a limited practical experience becomes a teacher, this will be of assisstance to him, but not as much as the more mature experience of an older man. In either case, a professor should not assume that having had a practical experience this is all sufficient, and that it simply rests with him to base his teaching on the results of this experience. To keep in touch with what is going on it will be necessary for him to spend much of his time in studying what is being done in the outside field, or to resort to the third method, and do practical work in connection with his regular college duties. If he does not do this he will soon fall behind-hand, and the efficiency of his instruction will be decreased.

The advantages of the second system of securing a practical experience, where the professor leaves the teaching field, takes up outside work, and then returns to teaching, are that during his practical career he will be very much alive to the points he should look into, and furthermore if he returns to teaching he will possess the advantage of having experience both as a teacher and as a practical engineer. We all know that there is much more to the right sort of teaching than a thorough knowledge of the subject to be taught, and that the old saying "a man must be born a teacher" contains much truth. It is indeed just as necessary that a successful teacher shall have the right qualities as an instructor, as that he shall possess the necessary knowledge. The main disadvantage of the second method is that if a professor makes a success in the practical field his pecuniary reward may, as already stated, be so great that it will be hard to tempt him back to teaching.

We will now take up the third method, where a professor obtains his practical experience by conducting outside work in connection with his college duties. In the first place, let us consider the subject from the standpoint of the man himself. If he is an enthusiast, this method of obtaining an experience will lead to harder work on his part than either of the others. This assumes that his college work is not neglected, and that by doing the outside work he is making his course at all times better and more useful to the students. In this connection something may be said about the methods of teaching in engineering schools. I believe that the one proper way to teach an engineering subject is for the professor at the head of a department to get down to hard work with his students, and to know each of them so well that he is thoroughly acquainted with their personal characteristics. Certain parts of his course can be turned over to assistants, but the moment he avails himself of the assistance of others to such an extent that he is no longer in close relationship with the students, his efficiency in instruction will be decreased. In other words, the professor must exert himself to the utmost to secure the best results with his students, and when this is done, there is no harder way to gain a practical experience than by

*Address delivered as Vice-President and chairman of Section D of the American Association for the Advancement of Science, at the New Orleans meeting.

the undertaking of outside work, and if the professor is an enthusiast there is often much danger of his breaking down under the strain. On the other hand, if he manages to secure an experience which will give him the reputation of being an authority in his field, he usually will make the best sort of a teacher, and be a credit to the college with which he is connected. All this assumes that the classes are not too large (and I am a thorough believer in comparatively small classes), and also that his teaching roster is so arranged that he will have time available for the outside work. It would certainly be unfair to expect a professor to gain a reputation in either research or commercial work if his time is so fully occupied with class work that, with the exception of his summer vacation, there would be little time except the evenings in which to do such work. One must not be misled, however, in thinking that if some definite time, say a certain number of days each week, is set aside for the purpose that this will make it an easy matter for the professor to undertake practical work. If he is an enthusiast he will find that he must often stand up to his task night after night, and unless he is willing to do this it is folly for him to undertake to gain an experience in the way indicated.

From the standpoint of the college, allowing the professors to undertake any and every sort of work to gain a practical experience is a most dangerous one. There is a tendency in many cases to do work for which the professor has not the proper capacity, and in this way he may throw discredit on his college. There is nothing that will so greatly damage the reputation of a professor, and in turn of the college with which he is connected, as the issuance of a report which shows him to be incapable of properly coping with the subject, or which is in the nature of an advertisement for this or that machine or commodity. The outside work undertaken by a professor should be that of a scientific or strictly engineering type. In much of the work his reports simply recite facts deducted from various test data, whereas in others it is necessary for him to render an opinion. There is danger in arriving at false deductions as well as in advancing of false opinions, and unless the professor can be thoroughly trusted, it would be better to cut out all such work. There is also a great danger of a professor bringing disrepute to his college if he is careless in his testimony as an expert. If his testimony in this line is wilfully misleading, or if he depart a hairsbreadth from truth, it were well that he had never been given the chance of lowering the dignity of his profession. On the other hand, a strictly honest and able man may bring credit to his college by his success and acknowledged fairness in this same line of work.

The advantage to a college in having its professors do research and outside work is that what reflects to the credit of the professor will reflect to the credit of the college. Furthermore the college will be looked to as a source from which an unbiased opinion can be obtained, and in maintaining this standard it will be fulfilling a high and useful mission. The results of the investigations may be made the subjects of scientific papers to be read before the various societies, and any reputation that a professor gains in this way will benefit his college. Furthermore the college gains through the acquisition of much of the apparatus used in the investigations. The college will also be the gainer financially, because if a professor is allowed to do professional work what he received from this source really pays a part of his salary. Aside from a financial gain in this way, however, it is a question whether a college should endeavor to secure any great financial return from such work. There should be enough earned directly by the college to pay for the use of the apparatus, the wear and tear, etc., and for providing a fund for the purchase of new apparatus for the work; but aside from this, it is my opinion that the college need not be the financial gainer. I say this because if too much stress is laid on the money getting side of the problem, it will not be possible to do the right sort of work, and to do it in a proper way. A party may be willing to pay a large sum for an investigation of a project where it is evident that no matter what results are obtained they will not add to the scientific knowledge of those undertaking the work, and where it is also evident that all that is wanted is the name of the professor, and that of the college with which he is connected, for promoting the project. Such work should never be undertaken no matter what the commercial returns may be. On the other hand, a poor inventor may desire to have a test made on some machine which he has constructed, and in which there appears to be a possibility of development, and such a test might well be undertaken although it may give no financial return. The proper sort of commercial work to do in connection with a college is that of a research character, or where scientific results are obtained. It will be found that when the work is limited to this sort that it often cuts off much that is of a less desirable nature, but in which the financial returns would be greater.

In all that has been said so far it is assumed that it is necessary for certain professors to have an experience in the outside field. I do not think any one will question this. One is apt to get into a rut in teaching and to have his mental horizon narrowed so that he cannot perceive his own faults, and there is no better way of expanding this horizon than to be a coworker with practical men. The main advantage that a practical teacher has over one who is purely the official is that he can make his course interesting by the introduction of practical examples, and in this way incite the students to study intelligently, which is the real measure of his success. He may, however, make the mistake of introducing too many practical details into the course. It is essential above all that the fundamentals of the subject shall be mastered, and the true use of practical problems, aside from securing the interest of the class, is to show that their solution is based on a few broad underlying principles. A practical man may also make a mistake in thinking that his way of looking at a problem is so simple and straightforward that it will surely be grasped by the students. In teaching, however, he will find that after presenting a subject in what he considers a way that all must understand, there will be many, possibly the majority of the class, that have failed to grasp his reasoning. Men's minds work differently, and the path taken to arrive at the understanding of a problem will vary, so that unless a subject is presented in several ways the explanation given by a professor may fail to fall into the line of thought of many of his students, and he will be disappointed in the results obtained.

It is a fact, however, that there are many professors who have had little or no outside experience. This often occurs where a young man enters the profession of teaching directly after his graduation, and is placed in such a position that it is impossible for him to undertake any practical work. Such a professor may make the best sort of a tutor, and may be most successful in imparting the fundamentals of a subject, but when it comes to being put in charge of a practical engineering department, it is here that his lack of experience will be very much felt. In a certain sense it is unfair for a head professor to secure the services of a recent graduate and keep him continually at teaching so as not to allow him to gain outside experience. Much thought has been put on this phase of the problem. Mr. Walter C. Kerr, in connection with his work as a trustee of Cornell University, has been in favor of the plan that a professor be thrown upon his own resources and be compelled to work in the practical field one year out of seven. This might appear all right from a business standpoint of the college involved, but how about older professors who have worked long in the teaching line, and have not had the necessary outside experience to qualify them for taking a position in the practical field? It might be very inconvenient for such a professor to have to accept a nominal salary in order to gain experience, but this certainly would follow if he had been so loaded down with teaching that he was given no opportunity to work at the practical side of his profession. On the other hand, if a professor through hard work and diligence has obtained experience in the outside field, while he is a teacher, and is forced, at the end of seven

years, to enter the practical field, it is very probable that his success therein may be such that he could not be tempted back to teaching.

From the foundation of the Stevens Institute to the present time, the professors have been encouraged to do practical work. At all times this work has been done on their own responsibility, that is, the Institute was not responsible for any of the reports given out. On the other hand, it has been well appreciated that should erroneous or undignified reports be made it would reflect discredit on the Institute, and great care has been taken that this should not occur. In 1894 the late Dr. Morton, who as you all know, was the first president of the Institute, established what he called the Department of Tests, the aims of which he described as follows:

"It is part of the Institute's policy to make its laboratories and workshops the center of such experimental investigations as will be of direct commercial importance to the mechanical engineering profession, and likewise contribute to the same valuable technical information by which the knowledge of facts and principles which constitute the foundation of that profession may be enlarged. It is also part of the same policy to have its professors so in touch with the most advanced practice as to enable them to embody, in their courses of instruction, the best results of applied science in engineering practice.

"A Department of Tests has, therefore, been organized to undertake measurements of the performance of steam engines and other motors, and of the efficiency of boilers, refrigerating machines, and mechanisms generally, including electrical and hydraulic apparatus, also to make tests of strength of materials, and to make various chemical and physical investigations, for the general public. Such work is assigned by the president to the member of the Faculty best fitted to successfully undertake any particular investigation, and the extensive facilities of the Institute in the way of working space, apparatus, workshop appliances, skilled observers, and mechanics are placed at the latter's disposal."

This might make it appear that all testing work from that time on was to be done by the Institute as an institution, but such was not the case. No other than personal reports have been issued by the professors who have undertaken the work, and in every case the professors themselves have been entirely responsible for the payment of all expenses connected with the tests. In many cases the expenses of tests are quite large, and the payment of these must be secured either by obtaining a retainer or deposit from the parties for whom the work is to be done, or the professor making the test must run the risk of having to pay these expenses himself should the parties for whom he is doing the work fail to meet their obligations. This looking after the financial end of the problem is an essential one as it gives the professors experience on the commercial as well as the engineering side of the work.

It has been claimed that the professors of an engineering college should not do work in the practical field as this interferes with the consulting engineers who depend for their livelihood on just the sort of work which would be apt to be undertaken at a college. This is a very narrow view to take of the matter, and as far as my own personal experience is concerned, I can testify to the fact that much of the work undertaken in connection with my college duties has been done for consulting experts. The day is passed when there can be a strict line drawn between the work of the consulting engineer and that of the professor who teaches in the same field. The ideal professor in a given line should be able to take up the work of the consulting engineer in that line, and the ideal consulting engineer should possess enough technical knowledge to fit him for being a professor. There should be no jealousy, but rather a bond of friendship in that the fundamentals which each should master are the same.

British-American Weights and Measures.

We have a letter from George Moores, secretary of the British Weights and Measures Association, in which he says:

Allow me to thank you for bringing the work of our association before the notice of your readers as you do at page 36, especially for your remark that we are evidently making a serious effort to solve the weights and measures problem "without belittling it or misrepresenting it." I wish this could be said of all who express opinions on the subject.

It is evident, however, from the article referred to, that I did not make myself clear to you in the conversation we had on the subject, and in so far as your premises are incorrect, your inferences are equally wrong. Seeing that I hope soon to be able to send you a printed work on our proposals, I will not take up your valuable space with further touching upon your remarks at this stage, but I would like to make it clear that the system I attempted to demonstrate to you as based on the inch is not my personal plan, nor can I, as secretary, say it is the preferable plan, until the committee of English-speaking peoples which it is desired to bring about should express the collective wisdom of themselves and the countries they represent, on the whole of the plans sent in for consideration.

It is admitted by those pro-meterists who really understand the system, and who look upon the whole subject of weights and measures reform without bias, that there are defects in the metric system which would have been obviated when the system was first inaugurated could its promoters have foreseen the needs of science and manufactures as they have developed during the last century. To correct these defects, and with the object of putting before the English-speaking peoples as perfect a system as possible before pressing for its acceptance, it is the object of our association to gather together all the best thought of the world on the subject, and then to have the various schemes considered by a committee composed of trusted representatives of all the English-speaking peoples. So far we have fifteen schemes put before us, and it is significant that three of these come from France, the last one, to hand only yesterday, from a French electrical engineer connected with one of the big railways of France, who, speaking of the meter, says it is "false, false, false."

Seeing that the manufacturing and commercial position of all English-speaking peoples at the present time is sound, and making greater progress than that of any other country, I trust you will agree with me that we may at present let well alone and push on with the foreshadowed inquiry. It will take some little time, but while a few years are much to an individual, they are as a moment in the life of a nation or a race, and it is the welfare of mankind that we have to consider in this question, and not selfish interests.

[When Mr. Moores visited us he had, and exhibited, several models designed to show the arrangement of the decimally divided inch and the other standards based upon it. That plan was the only one which he explained and we understood him to say it was the one so far favored by himself, personally, though of course he could not foreshadow or profess to anticipate the action of the international conference which he expects will be held. We thought we had made this clear when after describing the plan we said in the article referred to, "It is the plan which Mr. Moores himself favors, but he wishes before advocating the definite adoption of any particular plan, to secure a conference, such as we have mentioned."

It is our wish to present the objects and aims of Mr. Moores and of his association with entire fairness. We believe his plan of conference is a good one; only when it is held it ought not to be made an anti-metric conference but a conference to decide upon the best course for the English-speaking nations to follow, and the arguments in favor of adopting

the metric system should be presented and considered along with all others. Then let the best plan be adopted. It means very much that such an association as Mr. Moores represents, perceives that something ought to be done and proposes before it is done to get the benefit of the best wisdom of representative men.—Ed.]

France and England, says *Motor Age,* have begun a fight for European supremacy in the automobile trade. England, roused into action by the taunts at her slowness, stole a march on France by making the Olympia motor-car exhibition in November, a month ahead of the Paris *salon de l'automobile,* and by persistent hustling and decisive action gave the world the first peep at the best foreign cars that had been brought out for the world's market for the next season, and as a consequence sold a great number of automobiles. It appears that there will be, for the next show, a contest between the two countries for priority of date. This keen competition means progress, for early exhibitions alone will not sell cars. It also contains a lesson for American makers, who seem satisfied to put off exhibiting new cars until after the buying season has opened.

Worm Milling.

JOHN EDGAR.

Experience has shown that worms made with the lead long as compared with the diameter are the most efficient. This has also been shown to be theoretically correct. The steep angles and coarse pitches resulting from this practice make it difficult in most cases and impractical in many others to chase the thread in the ordinary way on a lathe. The most natural thing to do is to resort to milling, in fact special machines have been brought out and placed on the market to perform this operation.

A worm thread as most generally known is made to the 14½ degree involute system with a tooth shape in a plane parallel to the axis similiar to that of a rack of the same pitch. This tooth being composed of none but straight or right lines, (of course with the exception of the fillets which are, unfortunately, omitted in most cases), and which for the sake of clearness is shown in Fig. 1, where the standard proportions are given.

The question is: "Can this shape be produced on a worm by the ordinary methods of milling and without especially shaped cutters for each pitch and angle of helix?" Some will say that they are doing it every day. Have they ever given the matter any thought? Have they never noticed how the cutter drags on the side of the thread in some cases? "Yes! but remedy this by using smaller cutters." Granted; but is there not a limit to the diameter of the cutter? Even when the drag is not noticeable it is nevertheless present. It is this point that I wish to take up.

While this distortion in the shape will not cause any serious effect in cases of fine pitch and low angles, it becomes noticeable even in cases with thread angles of 20 degrees. The deeper the thread the more distortion we encounter, becausse the difference between the helix angles at the outside of the thread and at the root increases with the depth. It is this twist in the thread that is the cause of all the trouble.

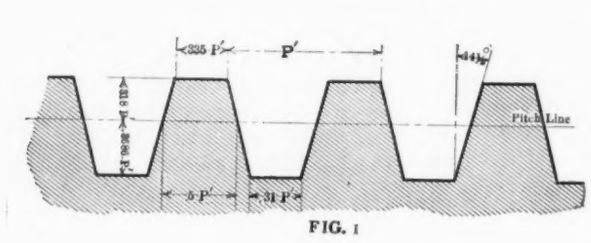


FIG. 1

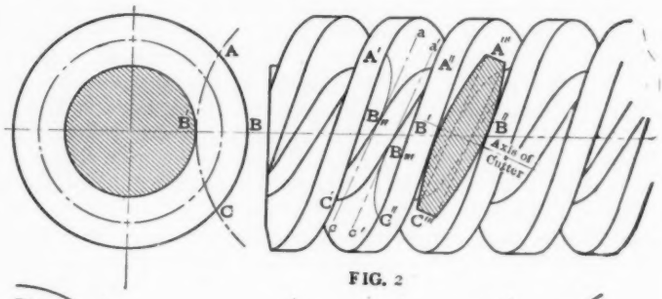


FIG. 2

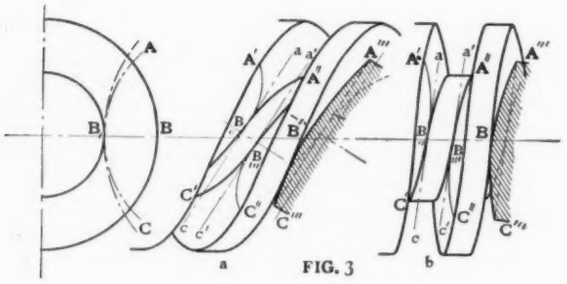


FIG. 3

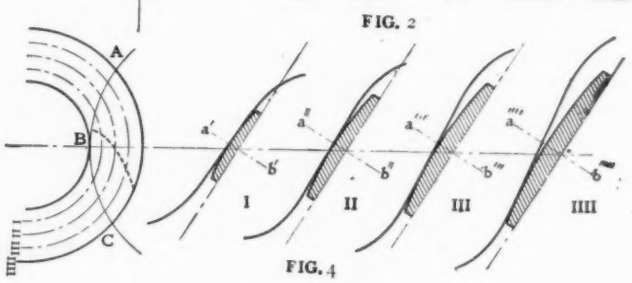


FIG. 4

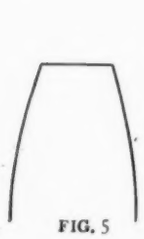


FIG. 5

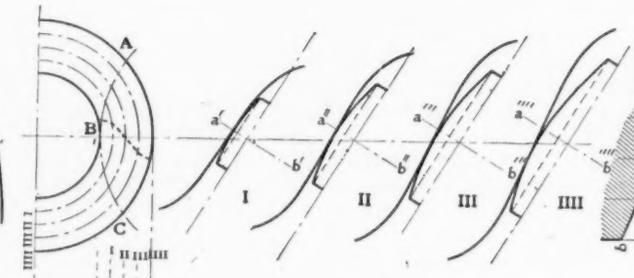


FIG. 6

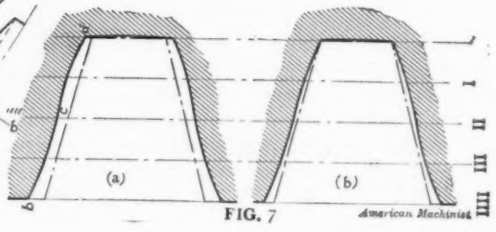


FIG. 7

THE GEOMETRY OF WORM MILLING.

The cutters used in milling worms are ground to a standard thread guage, similar to that used in lathe work and are expected to mill threads of standard proportions. Supposing for the instant that they reproduce threads or spaces similar in shape to the gage they are ground to, the thickness of the thread produced would have a different thickness, for any given pitch, and for every change in the angle of the helix. This could be easily remedied by making the cutter thinner than one-half the circular pitch and, by

shifting its position, mill the thread to the required thickness.

A milling cutter will not mill its own shape except when the direction of the travel of the piece milled is parallel to the direction of rotation or normal to the axis of the cutter. This, as is easily seen, is not the case when milling a worm, because the direction of the travel varies from the top to the bottom of the thread, the cutter being set at the average helix angle, which is usually taken as that of the pitch line, but is actually a trifle below it. The shape milled is always determined by the contact of the cutter with the work. The contact of a straight cutter to produce a straight surface must be in a straight line. To mill a circular surface the contact line must be a curved but not necessarily a circular line.

In Fig. 2 is shown two views of a worm having a coarse pitch but one that is not an extreme case. In the end view we have the line $A\ B_1\ C$ representing the sweep of the cutter. This line, projected on to the sides of the thread, is shown in the plan at $A'\ B_{II}\ C'$ and $A''\ B_{III}\ C''$. The lines $a\ e$ and $a'\ c'$ represent the outside edges of the cutter in the thread space. The line $A'\ B_{II}\ C'$ might be called the interference line because it shows the extreme position at which the cutter represented by $a\ c$ may be set. Should the line $a\ c$ intersect or cut the line $A'\ B_{II}\ C'$ we would have a drag at the bottom of the thread, the extent of which would be determined by the nearness of the point of intersection to the point A'. We may set the cutter at any angle so far as the bottom of the thread is concerned, but in every case the cutter must lie tangent to the line $A'\ B_{II}\ C'$. The position of $a\ c$ and $a'\ c'$ is that of the cutter when set at the pitch helix angle which shows that the cutter must be considerably narrower than the bottom of the space in order to clear the sides of the thread.

If we take a section of the cutter bounded by the line $A\ B\ C$, we would have in the plan a shape such as shown at $A'''\ B''\ C'''\ B'$ which gives us the point of contact with the thread and shows that the cutter must be somewhat narrower at the outside of the thread as well as at the bottom.

Fig. 3 shows two extremes treated in the same manner as the case shown in Fig. 2. The one shown at *a* would show a very badly distorted thread if milled with the ordinary thread milling cutter, while that at *b* would not be bad and would probably pass as satisfactory.

To show that it is impossible to mill a worm of considerable pitch by the ordinary method, let us lay out the case of Fig. 3 *a*, and find first the shape of cutter required to mill a proper shape thread and, second, what shape the ordinary cutter would mill. This can be done by taking sections of the cutter at different depths and also of the thread helix at corresponding points. This has been done in Fig. 4, where the cutter sections shown are cylindrical and parallel to the center lines of the cutter and at depths as shown on the end view, and indicated by the numerals I, II, III, IV. In the end view the line of contact of the cutter with the side of the thread is shown.

Keeping in mind the fact that we are now treating the case of a perfect thread and are working to find out the shape of a milling cutter necessary to reproduce this thread shape, we can, by studying the line of contact almost picture the cutter shape without actually laying it out. The shape is shown in Fig. 5 and is obtained by taking the width of the space at the line of contact or the width of the cutter sections shown on the line $a\ b$, $a'\ b'$ etc.

Had the point of contact been normal to the axis of the cutter at all points from top to bottom of the thread, the line of contact would have been a straight line and the cutter would have had straight sides, which, however, would not have been at an angle of 14½ degrees as in Fig. 1, nor would the cutter have been of standard thickness.

Now that we have found the shape of a cutter that will mill a standard worm thread, let us examine into the case in which a cutter as ordinarily made is used and find what shape thread it will produce. This we can do by laying out sections of a cutter at the proper angle and laying the corresponding helix tangent to them as shown in Fig. 6, where, as before, the cutter sections are taken on the circular arcs I, II, III and IIII. The line of contact is quite different from that in Fig. 4 and would suggest a double curved thread shape instead of the straight angular shape of the standard. The actual thread shape may be found by taking the width of the space at the depths shown, and this has been done in Fig. 7, *b*, being taken parallel to the axis of the cutter or on the normal pitch helix line, $a\ b$, $a'\ b'$, etc., while that at *a* is taken parallel to the axis of the worm, this latter showing the deviation from the shape given in Fig. 1 and which is reproduced here in dotted lines.

The shape from *c* to *d*, Fig. 7 *a* is caused by the edge of the cutter dragging in the bottom of the space or as explained above, by cutting the lines $A'\ B_{II}\ C'$ and $A''\ B_{III}\ C$ Fig. *a*. The shape from *c* to *b* is caused by the drag of the cutter above the pitch line while the extra width of space is on account of no correction having been made in the thickness of the cutter for the angle at which it is set.

It is obvious from inspection of Fig. 6 that the smaller the cutter is the nearer we come to perfection, but the cutter can never be so small as to completely cover the difficulty. The nearest we can come to this is by using a bevel end mill which gives an approximation that comes well within the requirements of practical work. This style of mill while it gives a better finish does so at the expense of considerable time but this may be helped by first roughing out the thread with the ordinary cutter, being sure to leave plenty of stock for the bevel end mill to remove, or where the pitch is not too great the finishing may be done in a lathe in the ordinary way. By doing this we may be sure of obtaining a better bearing on the worm gear, as it is clear that a thread shape, such as shown in Fig. 7, would be anything but satisfactory.

There are obviously two ways of taking the section for the standard comparison—parallel to the axis of the worm, as in Fig. 1, or on the normal helix. By taking the latter we could use cutters of one thickness for a given pitch, no matter what angle of thread was being milled, while with the former we must use cutters of a thickness corresponding to the angle at which they are set. There seems to be no reason for the parallel section other than convenience in grinding the thread tool. Why not treat worms that are to be milled as spiral gears? A difficulty would be found in using a hob to cut the worm gear but this hob could be made to correspond with the worm in shape, with but little trouble.

Seven-league Boots in the Twentieth Century.

The newspapers describe (and illustrate) the following alleged development in the transportation line, stating that the project of equipping the Italian army with these boots is being considered!

Parisians were startled yesterday by seeing a big-booted man whizzing along the Avenue des Champs Elysés, thence to the Bois de Boulogne at the rate of 25 miles an hour. It was Constantini, the inventor of motor boots, displaying the new footwear. The boots resemble tiny automobiles 15 inches long, fixed on high boots. Each has four rubber-tired wheels 8 inches in diameter. Accumulators are carried in a belt. They transmit by wires 1¼ h. p. to each motor. The motors can be run at a speed ranging from six to thirty miles an hour. Each boot weighs 16 pounds, but as the feet are not lifted up the weight does not matter. Constantini says he has traveled several hundred miles with them. He intends to travel from Paris to St. Petersburg on them. When asked what would happen if one motor started at the rate of six miles an hour and the other at thirty he became diffident and declined to discuss the subject.

Neither the number of ampere-hours of which the storage battery is capable, nor its weight, are given; neither is it stated whether the rider (or walker?) has his skeleton artificially reinforced so as to support this weight at his belt. We must say that, despite this description the illustration we have seen certainly does look as if there were the ribbed cylinder of a little gasolene engine between the wheels.

The First Allis-Chalmers Steam Turbine.

The first steam turbine put in operation by the Allis-Chalmers Company was recently started at the Washington Street power-house of the Utica Gas & Electric Company, Utica, N. Y. Fig. 1 is from a photograph of this outfit, which consists of a turbine rated at 1,500 kilowatts normal load and running at 1,800 revolutions per minute, direct coupled to an Allis-Chalmers two-phase 60-cycle revolving-field alternator, operating at 2,500 volts. The unit has a continuous overload capacity of 25 per cent., with a three-hour 50 per cent. overload capacity without exceeding a safe generator temperature, and capable of a 100 per cent. safe momentary overload. Artificial ventilation by means of an electrically-driven fan blower will, however, enable the unit to be run safely beyond its rated overload capacity.

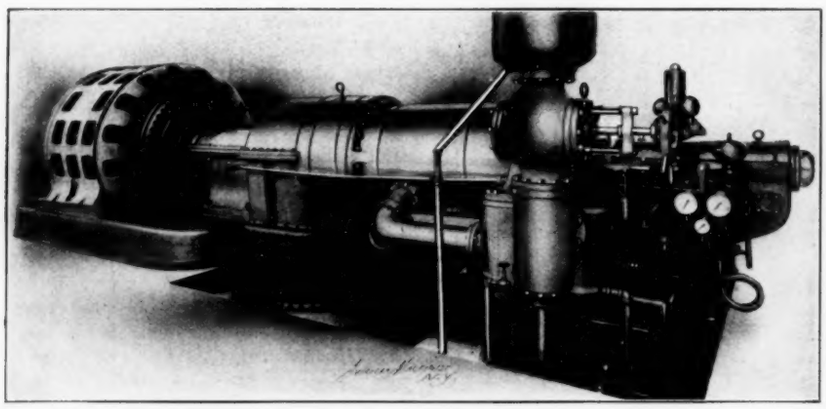


FIG. 1. 1500-KW. TURBO-GENERATOR.

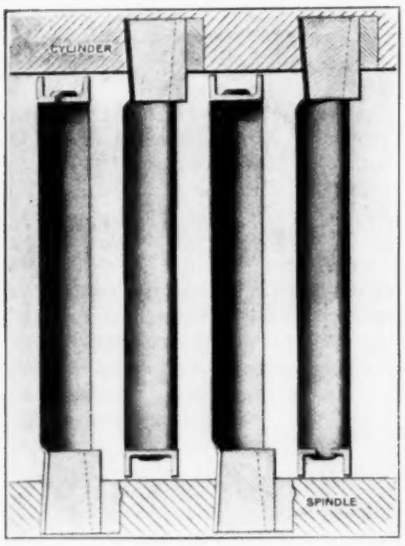


FIG. 2. DETAIL OF BLADE ATTACHMENT.

The turbine is of a modified Parsons type, the most prominent of the modifications being the mechanical construction of the blading, which is illustrated by Fig. 2, which was photographed from a drawing, being a portion of a longitudinal section through the spindle and cylinder, or casing of the turbine. The roots of the blades are formed in dovetail shape by special machinery and are inserted into slots cut in the foundation or base ring, these slots being formed by special machine tools in such a way as to exactly conform to the shapes of the blade roots. The foundation rings themselves are of dovetail shape in cross-section, and are inserted in dovetailed grooves cut in the turbine cylinder and spindle, respectively,

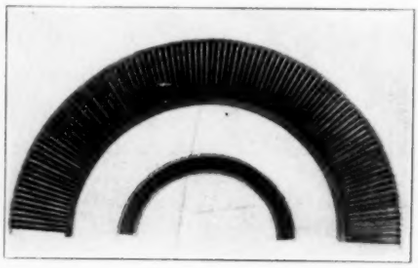


FIG. 3. LARGEST AND SMALLEST HALF-RINGS OF BLADES FOR STEAM TURBINES.

in which they are firmly held by key-pieces, as shown in the drawing; these key-pieces, or rings, after being driven into place, being upset into undercut grooves, in order to still further insure the integrity of the construction. In order to reinforce and protect the tips of the blades, they are formed with a shouldered projection which is inserted into a slot punched in a shroud ring, the slot being punched by special machinery in such a way as to produce accurate spacing, and at the same time form the slots so that they will give the proper angles to the blades independently of the slots in the base ring. After the blade tips are inserted in the slots in the shroud rings they are riveted over by specially arranged pneumatic machinery.

The shroud rings are made in channel shape, with outwardly projecting flanges,

FIG. 4. PORTION OF BLADING AND SHROUD RINGS.

which, after assembling in the turbine, are turned and bored to give the necessary working clearance. The flanges of the channels are made so thin that, although they are amply sufficient for stiffness, the shroud ring does not have the disadvantage of a solid shroud, which is liable to acquire a dangerous temperature by friction in case of an accidental contact of the rotating and stationary parts. One object of this form of construction is to enable the working clearance to be made smaller than in the case of naked blade tips, without danger in case of accidental contact, thus reducing the leakage loss to a minimum; the leakage past the blade tips being the principal source of loss in the steam turbine. This construction also has the advantage that in case a blade should be defective, it is so held in place by the shroud ring that it cannot possibly work loose and produce damage. In this method of construction the entire blading is produced by machinery, thus eliminating the personal equation which enters into blading done by hand-work. The blading is made up in half-rings in the blading shop and is carefully inspected before be-

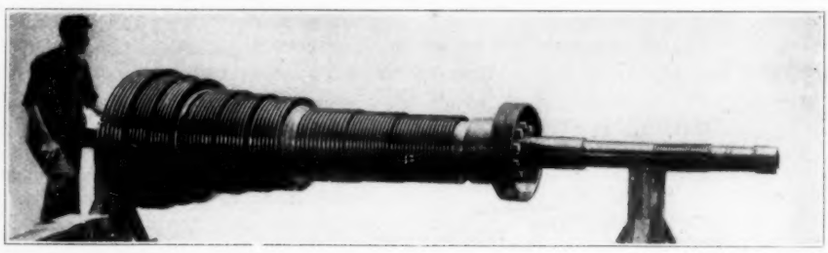


FIG. 5. SPINDLE OF TURBINE.

ing inserted in the turbine. The largest and the smallest half-rings of blades used in the Utica turbine are shown in Fig. 3 ready for assembly in the turbine. Fig. 4 is from a photograph of a portion of the blading, and shows several of the channel section shroud rings. It will be noted in Fig. 5, which is from a photograph of the spindle, that the low-pressure "balance piston" cannot be seen, only two balance pistons being visible instead of the three pistons formerly used in this type of turbine, where it is said to have been found difficult to produce a balance piston of the size required for balancing the low-pressure stage of the turbine and at the same time make it sufficiently rigid to run with the necessary small working clearance. There is, however, in this turbine a third balance piston, but instead of being at the high-pressure end of the turbine, as formerly arranged, it is at the low-pressure end, and, as it is smaller than the large end of the spindle, it is hidden from sight in the illustration. By making this piston in such a way that its circular area is equal to the annular area of the piston used in the older construction, the low-pressure balance piston is made much smaller. Instead of reducing the leakage past this piston by means of "dummy packing," as in the high-pressure and intermediate pistons, and as used in the low-pressure piston of the older construction, a labyrinth packing of radial baffling type has been adopted, thus eliminating small axial clearance in the turbine. A considerable advantage is claimed for this construction in permitting of the use of smaller working clearances in the high-pressure and intermediate balance pistons.

The Allis-Chalmers Company, in entering the steam-turbine field, effected an alliance with the Turbine Advisory Syndicate of England, thereby securing the co-operation of the firms therein interested, including Messrs. Willans & Robinson, the famous high-speed engine builders, of Rugby; Yarrow & Co., the well-known torpedo-boat builders, of the Isle of Dogs, London, and the Neptune Shipbuilding Works, Walker-on-Tyne. The Utica turbine, in fact, was built for the Allis-Chalmers Company by Willans & Robinson, to whom a number of turbine contracts were sublet by the Allis-Chalmers Company before the latter had perfected the installation of its special machinery for turbine manufacture. At present the Allis-Chalmers Company is building its steam turbines in its engine works at West Allis, but it is extending its works, and one of the three new manufacturing buildings will be entirely given up to the manufacture of steam turbines. The first steam turbine of the Allis-Chalmers Company's own make, of 5,500 kilowatts capacity, has recently been shipped. The company will have the assistance of the Hon. Charles A. Parsons, C. B., in obtaining information for this line of engineering.

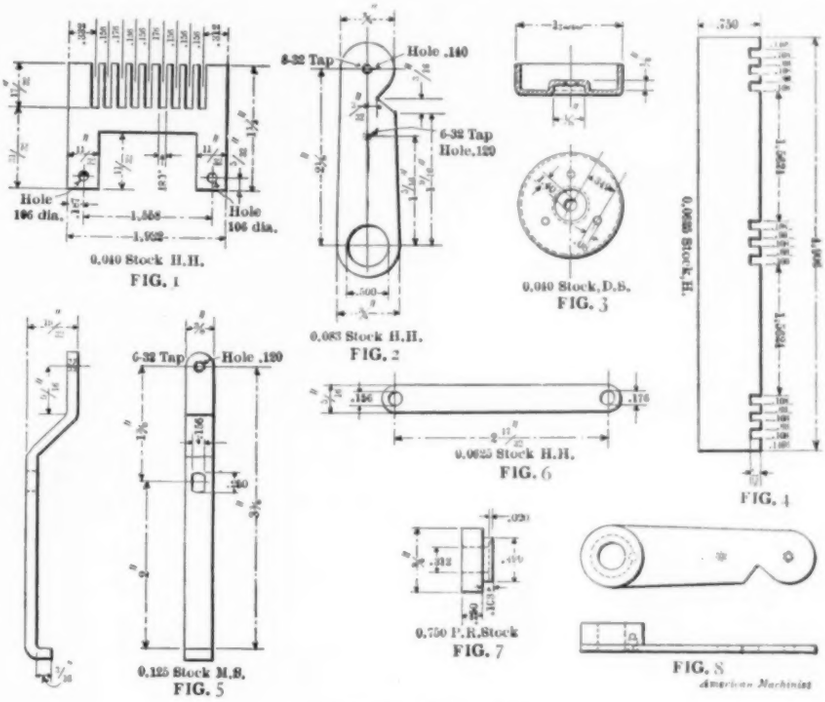
Cold Drawn and Rolled Steel in the Manufacture of Light Machinery.

BY FRED W. MC ARDLE.

To a mechanic accustomed to the methods employed in the manufacture of medium weight and heavy machinery, the use of cold rolled sheet steel and drawn rods as the principal materials of machine construction will be somewhat of a novelty. In the average shop sheet steel may be used for templets, covers, etc., and rod stock for connections and similar work where lightness is required, but the employment of these materials, except in a small way, is of course out of the question.

There is, however, a class of machinery where cold rolled or drawn steel forms practically the whole machine, aside from a few parts, such as base, frame, and some miscellaneous details, and even in the case of these few members, it is more a question of expediency than a necessity that they are cast rather than made from sheet steel. Cold finished stock is used to some extent in other light work, but in the class of machines to which typewriters and adding machines belong, fully 90 per cent. of the pieces are made from such material; and as the adding machine is more complicated than the typewriter, a better idea of what can be done with this material may be formed from it, and so this article is based on that machine. There is a still greater use of rolled and drawn stock in clock and similar construction, but this work is so different in character that it need not be gone into here.

In building adding machines, it is essential, from the multiplicity of parts, that each be made as light as is consistent with strength, otherwise the finished machine will be not only heavy, but bulky as well. The average adding machine occupies a space of perhaps 10 x 15 to 18 inches x 10 to 12 inches, according to the make, and the weights of the different machines vary from 50 to 80 pounds or more. In these machines there are from 1,500 to over 3,000 parts of all kinds, and it follows that a fraction of an ounce on each lever, connection and shaft will increase or diminish the weight of the machine by several pounds. Some of the parts, such as frames, base and case, being cast, will alone weigh almost, if not quite as much as the rest of the machine, notwithstanding they are made as light as they can be cast, the webs being from



ADDING-MACHINE PARTS.

⅛ to 3-16 inch thick and the ribs even lighter.

These conditions have resulted in a construction where as little gray iron is employed as possible, unless the substitution of sheet steel would be too expensive either for tools or handling, in which case, castings are grudgingly used. The cold rolled steel presents a finished appearance, and is ordered from the mill, rolled to within 0.001 to 0.002 inch of the nominal size; this is something of a proposition, as the middle of the strip is apt to be somewhat heavier than the edges, but it can be obtained close enough to the requirements, so that there will be neither too much play nor too tight a fit on the studs and screws that in many places act as bearings. If the size of the order warrants it, the steel is delivered from the mill in the various widths to suit the dies by which the

stock will be punched. The stock used is of various thicknesses, the most of it being 0.040, 0.0625, 0.083 and 0.125 inch thick, some few pieces running under the first, but seldom any over the last thickness.

The steel comes in various grades of stiffness, such as "dead soft," which may be bent double, or cold drawn, medium soft, half hard and hard, the latter being utilized where no forming is required, and the piece is to be rigid or have a bearing surface without being case hardened. Medium soft and half hard grades are most extensively employed, the latter giving a clean cut after passing through the dies, especially if "shaved" to get a smooth edge. If the stock is too hard it cannot be formed without cracking, and if too soft there is a tendency to draw the metal at the punched surfaces. Dies are made for every piece which can be made from a punching to advantage, the character of the die being such as suits each particular piece. Some of these dies are simple in construction, costing only a few dollars, and others are combination dies; other dies are made up of a number of pieces and are absolutely down to figures given on the drawings.

A piece like Fig. 1 is blanked, and then a number are milled with a gang of cutters, as the necessary dies would be very expensive, and the results somewhat uncertain, the edges of the tongues being bearing surfaces and the width of the slots admitting of little variation; and a great many pieces can be milled for what the dies would cost, and the results are more certain. The simpler pieces like Fig. 2 are made in tandem dies, and require only tapping or countersinking before being ready for assembling.

Other dies, for pieces like Fig. 3, are combination affairs, which blank and draw the piece at one operation. Most of the dies are made with an allowable variation from the dimensions given on the drawing, of 0.0005 inch oversize for holes, and 0.001 inch on distances, some parts, however, requiring to be still closer than this, and the particular case in Fig. 4 requiring almost absolute accuracy. This piece is shaved or repunched, and the slots are guides for other pieces, and must be sheared smooth; the dies are each made up of a number of pieces and held in a shoe, which enables the tool room to keep them to size with little difficulty. Fig. 5 shows a piece which takes the place of the bent lever in ordinary construction, and Fig. 6 is a connection such as is used throughout the machine. In some factories sub-press dies are employed extensively, and for large quantities are more economical, though more expensive in first cost.

Moving hand in hand, as it were, with the punch press, is the screw machine, on which all turned work used on the adding machine is made, the lathe being used only for experimental and tool work. All stock for screws, shafts, hubs, etc., is ordered from the mill, with an allowable variation of 0.0005 inch under size, and as a matter of fact, the material usually varies less than 0.00025 inch from the nominal size. The stock used is known as pump rod, and is slightly higher in cost than screw stock.

The hubs are similar to Fig. 7, and are utilized in connection with levers such as Fig. 2. These levers are countersunk 0.020 inch deep on one side, and the hubs are made with a rim 0.020 inch deep as shown. These are put together and staked in a punch press, the rim on the hub filling the countersink flush with the face. For further security a "dutchman" is driven in the joint, and a light, neat and strong lever is formed, as shown in Fig. 8. These finished levers together with the shafts on which they are to be pinned, are put in jigs, sometimes several levers being on one shaft, each of a different length, and set at a different angle. In these jigs they are drilled and reamed, and taper pins are driven, and when taken out, a permanent section is the result. Other punchings and screw machine pieces, or punchings only, are assembled to make up various parts or sections, and the effect presented, when the entire machine is assembled, is that of a compact, light and artistic machine, but withal a complex one. A further result attained with this method of construction is, that all parts are interchangeable.

Gages for all screw machine pieces are used, and wherever any parts not produced on the punch press or screw machine are made, all are finished in jigs and fixtures, and to gages. Test gages are employed in assembling, where necessary, and a high grade product is the result.

The dies and tools for this work are all expensive, and, in their manufacture, call for first class tool and die makers, but the results obtained, and the perfection attained, make the first cost a minor consideration, and when one becomes accustomed to this form of construction, he soon becomes a convert to the "tin and wire" method for light work.

The latest bulletin of the United States Board on Geographic Names contains one order authorizing a change of name which deserves a wider publicity. We quote it in full as follows: "BEAVER; brook tributary from north to Souhegan River, Hillsboro county, N. H. (Not Quohquinapassakessamanagnog, Quohquinapassakessananagnog, Quohquinapassakessananaquog, nor Quoh-quina--passa-kessa-nanag-nog.)" A change from any of the Quoh-what-you-call-thems to Beaver appears entirely justifiable. An aboriginal name of such a length is out of place anywhere, save possibly on an extra long Pullman car.—*Engineering News.*

Machine for Making Sheet-Metal Segments for Large Dynamos.

The punchings for large dynamos, which are of thin sheet metal of segmental form, constitute a considerable item in the total cost of construction, and in the case of large machines not usually built in duplicate, owing to the items of power, speed, voltage and other considerations which demand modifications in the design, it is advantageous to have tools which are rather flexible for making the segments.

While it is true that these segments can be blanked most expeditiously by a die which cuts the full shape at a single stroke of the press, in many cases this may not be the most economical method, owing to the cost of the die. To meet these conditions, a set of machines has been designed and constructed by Zeh & Hahnemann, Newark, N. J., and illustrations of these tools are herewith presented.

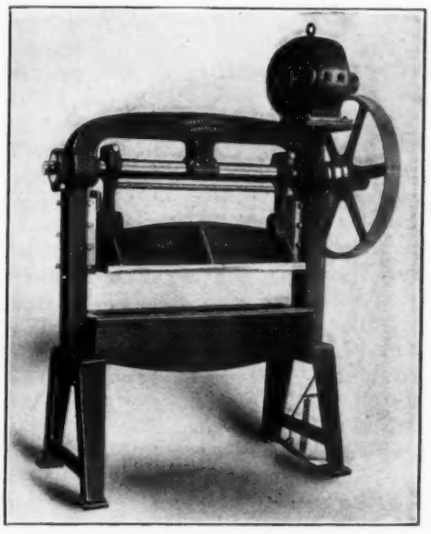


FIG. 1. DOUBLE CRANK PRESS, FIRST OPEN AT TON.

The machines are especially adapted to this work when the dovetails which are used to locate and fasten the segments are female, in which case the material can be cut to a considerably better advantage than otherwise.

The full sheet of metal passes first a double-crank power press, Fig. 1, which punches the holes that later form the dovetail notches, and cuts the slots for the ends of the segments, as indicated in Fig. 2. The dies for these notches, as well as the slitting knives, are adjustable within wide limits and can readily be set by means of a suitable templet. Plain gages are provided to space properly the succeeding cuts.

The sheet thus prepared passes through a circular shear with segment attachment, Fig. 3, which cuts the segments apart; finishing the periphery as shown in Fig. 4. The segment attachment is of compact and interesting construction, it consisting of a

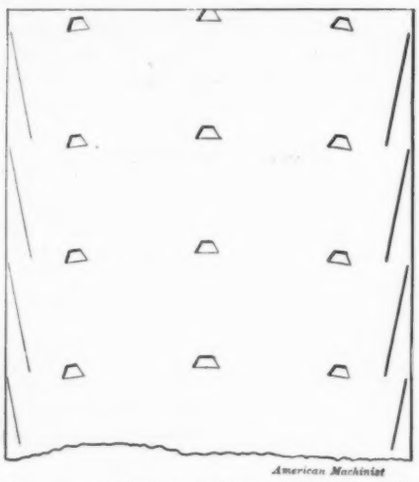


FIG. 2. SHOWING SHEET PUNCHED FOR DOVETAIL NOTCHES AND SLOT FOR SEGMENT ENDS.

sector of suitable form which is guided by anti-friction rolls; the sheet to be cut is fastened to this sector and guided by it in a circular path past the cutters, the guiding rolls being near the cutters to prevent vibration. The same sector can be used, within certain limits, for varying radii, as the gaging parts can be fastened to adjustable arms, thus allowing work to be cut to any radius with a limited number of sectors.

The segments prepared in this manner are ready now to be notched and trimmed on the inside. The notching machine, Fig. 5, has a guiding sector similar to the segment shear, but this sector has cut in its periphery notches in which a feed-pawl actuated by the press engages, thus feeding the sector with the attached segment automatically forward step by step. A stationary pawl locks the sector in position ere the punch enters the material, and the machine stops automatically after the predetermined number of strokes are made.

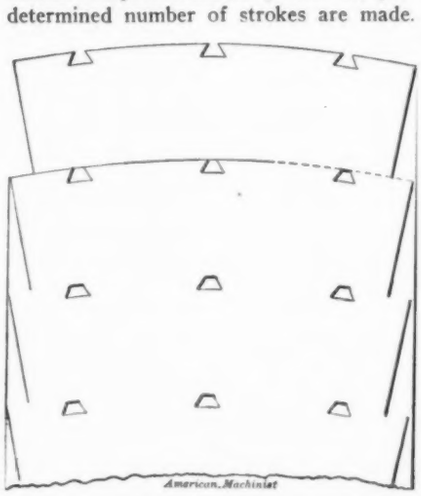


FIG. 4. SHOWING RESULT OF SHEARING OPERATION.

While cutting the notches, the die being suitably shaped, the inner edge of the segment is finished also, as in Fig. 6.

Ordinarily, for handling a given segment in this machine, only a sector with the proper number of notches and of suitable radius has to be made, as the notching dies (which are quite simple in construction) are usually standardized as to shape to allow their use on other segments. Since the masses to be accelerated at each stroke of the press are small, the machine can be run at good speed without endangering the accuracy of the results.

The rotary shear and the notching machine can be used for cutting and notching full disks or rings of smaller diameters by substituting suitable attachments. The notching press will notch segments and rings on the outside as well as inside; and, as the throat of the press is 18 inches deep, the internal notching of segments and rings up to that width is possible.

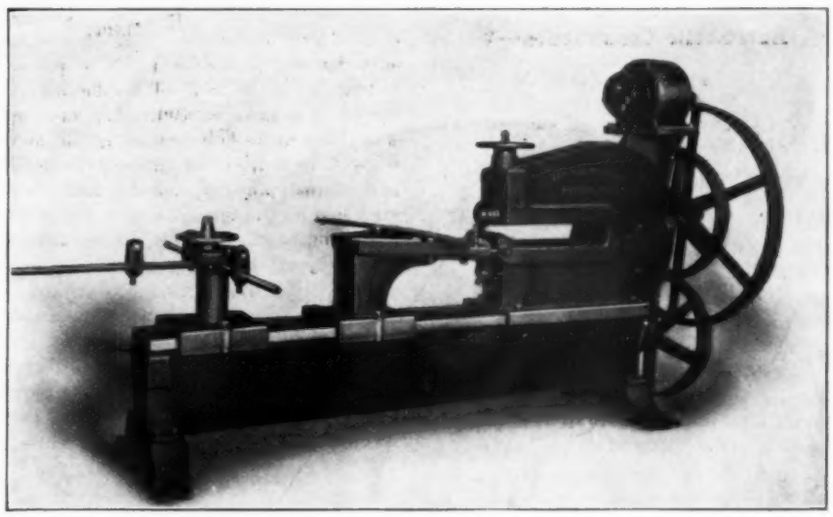


FIG. 3. CIRCULAR SHEAR WITH SEGMENT ATTACHMENT.

It is obvious that there is no upper limit as to diameters, as the machine will take in work of any curvature up to a straight line, this result being obtained without the sacrifice of floor space or other inconveniences.

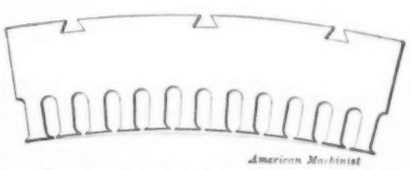


FIG. 6. THE SEGMENT NOTCHED AND TRIMMED.

While the illustrations show the machines direct connected to electric motors, they can be arranged for belt drive if desired.

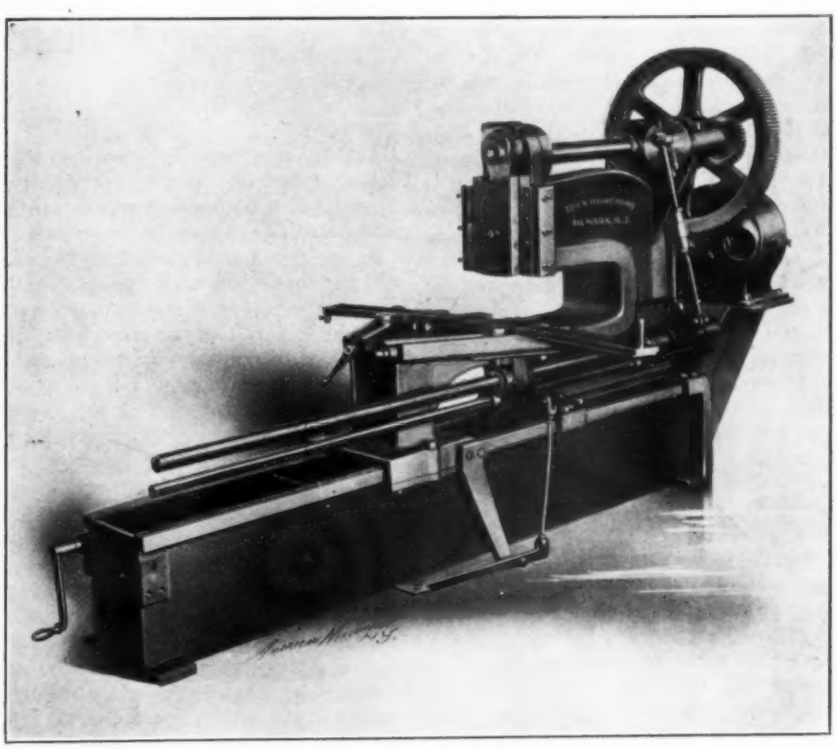


FIG. 5. NOTCHING MACHINE.

Automobile Construction—V.

BY F. C. MASON.

This chapter will treat of water circulation for cooling the cylinders.

In water-cooled autos the primary object is to carry as small an amount of water as possible to cool the cylinders down to about 170 to 190 degrees Fahr.

There are a great many types of coolers. One of the most popular and also the most expensive is the honeycomb, the cellular tubes in which have water openings ranging from 1-64 to 1-32 of an inch. In this type the object is to break the water into as thin a sheet as possible and cool rapidly with the air circulating through the cellular openings. This type of cooler never appealed to me for the poor man's car, as the cooler is always the first thing to be injured in case of accident and the honeycomb type is expensive and difficult to repair.

The next most popular type is of tank and tube variety, the tubes having radiating fins. There are two varieties of these. One kind has a tank top and bottom and tubes set between. The tubes are usually staggered, the centers ranging from 1 to 2 inch according to the size of the cooler. In this kind the water is forced to the upper tank, flows through the tubes to the lower or receiving tank and from there is pumped to the engine.

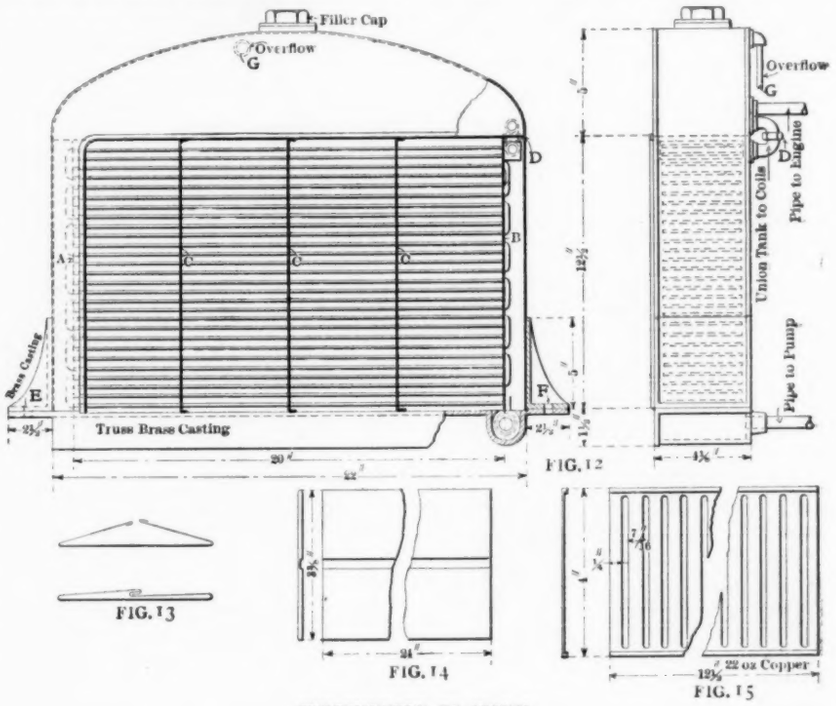
The other type has the tank at the top and a bank of tubes below, lying horizontally. These tubes are held by two headers, which also act as supports for the tank.

The tubes run in parallel rows with three or more in each row and each layer has return bends joining one end to the tubes above and the other to the row below, thus forming one continuous pipe (or pipes in parallel). The action is the same as if one long straight pipe, but the affair is made in this manner to save space. This latter type is a very good one; it is also expensive to make, as the return bends are hard to form without a number of special tools, and the radiating fins which must be sweated to the tubes, require a good die for making. Taking all together it would be much cheaper to buy than make.

The type of cooler shown herewith is used on one of the most approved American cars and I think is ideal. My construction is perhaps not exactly the same, but I have figured it out to permit it to be made with as few special tools as possible.

Fig. 12 gives a front elevation and an end elevation of this cooler. The main parts are a tank and 28 flat copper tubes 3½ inches wide by 1 inch thick by 20 inches long. These tubes are made of 8-oz. copper blanks 7½ inches wide by 20 inches long.

The tubes are folded upon a tinner's folder and the seams are then locked together, as in Fig. 13. The tube is then slipped over a mandrel, Fig. 14, and the seam flattened and soldered. The headers *A* and *B* Fig. 12, and the middle stays *C* are made of 22-oz. copper. The stays and head have to be punched as in the detail Fig. 15, to receive the tubes. The punch and die are the only special tools to be made. The die should cut a slot 0.110x 3½ inches and is easily made, using a stop to space the slots 7-16 inch center to center. The tubes should be put into the headers and stays one at a time and soldered fast. The return ends for the pipe can be made in a number of different ways. The easiest method would be to make a pattern and cast them of brass; do not make them over 3-32 inch thick.



CONSTRUCTION OF COOLER.

However, they can be made of sheet copper if desired. As the area of one of these tubes is not enough to take care of a ⅝ round tube, I connect two in parallel. The upper end is connected to the tank and the lower end to the pump. In the construction shown the tank and case are integral and can be removed from the outside of the coils by unscrewing union *D* and taking out bolts at *E* and *F* in case of any needed repairs. This idea is new and I think very necessary, as you are liable to spring a leak most any time even with the best construction.

The tank and outside case should be made of brass. *G* is an overflow pipe to take care of any expansion of the water in case of excessive heating. The fan is not shown but is placed directly back of the coils and should be about the same type as a 16-inch standard electric fan and run at about 2,000 revolutions. The blades should be curved and speeded in the right direction to blow forward against the tubes. Its principal use is for cooling when you are going very slow or running the engine at a stop. To make a good cooling system two things are required: plenty of cooling surface and a rapid circulation.

Turbine Locomotive.

Prof. Johann Stumpf, of Königliche Technische Hochschule, Charlottenburg, Germany, has secured patents upon an adaptation of the steam turbine to locomotives. He proposes to divide up the turbine into stages, distributed one on each driving axle of the locomotive, and the steam from the boiler to pass through the several stages in succession. A turbine is mounted on the axle on the outside of each driving wheel. With three driving axles the steam is conveyed by a pipe from the boiler to the first turbine on the one side, then to the other two turbines in succession on that side. It is then conveyed to the three turbines in succession on the other side of the locomotive, from the third of which the steam pipe leads the exhaust to the exhaust blast nozzle.—*Railway and Engineering Review.*

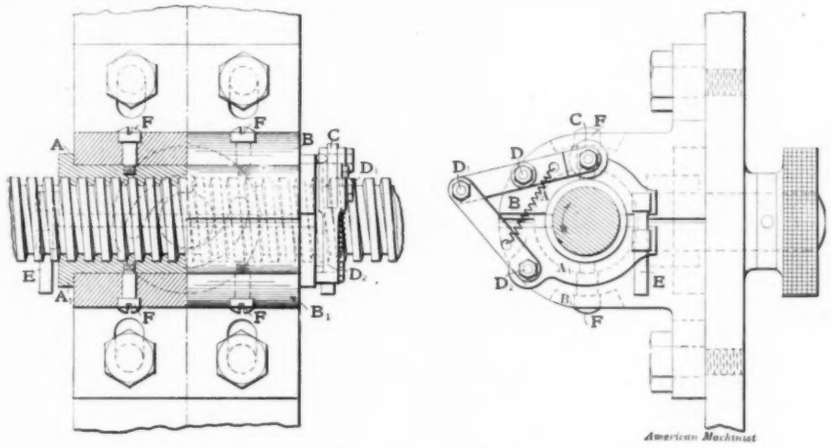
It is, perhaps, not quite fair to criticize a design without having seen the drawings, but when we picture a locomotive constructed in this manner at the head of one of our 1200-ton freight trains, it seems a little difficult to believe that upon opening the throttle the steam blowing against the blades of the direct-connected turbines will cause the engine to walk off with that train. We are, however, quite open to conviction.

Frequently it is not lack of ability, but lack of attention, that causes a man to do poor work.—*The Wood-Worker.*

Letters to the Editor.

Applications of the Newall Correcting Device to Precision Lathes.

In the article that appeared at page 734, Vol. 28, Part 28, describing recent improvements in the Newall measuring machine, you compare the method of correcting the inaccuracy in the screw with that employed on the precision lathe described at page 619, as an example. It may be of interest to readers of the AMERICAN MACHINIST to know that the Newall patent covers the application of the device to the lathes, etc., and I enclose herewith a sketch showing one method of application. The illustration shows the device applied to the ordinary form of half nut on the lead screw of a lathe. Instead of being screwed internally, the half nuts, *B* and *B*1, carry the half sleeves



COMPENSATING DEVICE FOR LATHE LEAD SCREW.

A and *A*1, which are attached thereto by the screws *F*. The seatings of the screws *F* are radial to the center of the guide screw so as to allow the screwed half nuts *A* and *A*1, to oscillate. Undulations made on the crest of the thread will cause movement to the two levers pivoted at *D*, *D*1 and *D*2, and thus move the screwed half nut *A*1 in the desired direction. The motion so applied to the nuts *A* and *A*1, has the effect of making the saddle carrying the cutting tool to lose or gain motion as desired. The screwed half nuts *A* and *A*1 maintain their relation during all movements by the guides *E* which are fixed in the bosses on the half *A* and slide in the bosses on the half *A*1. Two, three or four of these guides may be used.

A spring is shown in the sketch to keep the roller always in contact, but this is not essential in the forward movement, as the motion of the lead screw, transmitted through the half nuts, will keep the roller in contact. When the plain half nuts *B* and *B*1 are opened, the screwed half nuts *A* and *A*1 are withdrawn from the guide screw, and the same motion has the effect of lifting the roller from the crest of the guide screw.

The thread of the lead screw can be made extra deep, so that the amount removed from the crest to correct the error in pitch does not materially diminish the strength of the thread nor reduce its wearing surface.

The lead screw shown on the illustration is 1½ inch in diameter and has four threads per inch; therefore, as the roller bears on its circumference the amount of space available for the correction of error in the pitch of the screw is over fifteen feet for every foot of movement in the saddle. J. E. STOREY.

Warrington, England.

Brazing Gray Iron.

Noticing that G. V. Huber says on page 812, Vol. 28, part 2, that gray iron cannot be brazed with common brass and borax, I must say I do not agree with him, and I send you a sample to prove my claim.

The article by G. H. N., page 682, Vol. 28, part 2, is correct and not at all misleading to the young mechanic, but will prove very useful to the young, and some of the older mechanics as well. I have found it very useful in mending old and making new gray iron patterns. After fastening firmly together with norway iron or mild steel, so the parts cannot get out of place when heated, I heat very hot, and continue the heat steadily for a considerable length of time, to burn out the free graphite. Then apply plenty of borax and brass filings or granulated spelter, and continue the heat, keeping the brass flowing through the joint for some time, I do not hasten the operation. The sample I send you was mended in this way, and was broken off at both ends with a hammer without breaking at the brazed joint.

Mr. Williams in his article, page 781, Vol. 28, part 2, mentions the use of a chemical for the purpose of removing the graphite, this no doubt hastens the operation, but I do not think it will make it any stronger, and I don't think it at all necessary.

[We consider the article at page 682 to be misleading in that G. H. N. does not state that the heat should be "very hot" or continued for a "considerable time" but merely says "heating the piece sufficiently to melt the brass." The sample sent is a first class job. We used a hammer upon it without starting the brazed joint.—Ed.]

Restoring Gloss to Tracing Cloth—Dash Between Feet and Inches—Gunpowder Gas Engine Starter.

To restore the gloss on tracing cloth after erasing ink lines, it is of first importance that the erasing be carefully done, and a sharp knife eraser, if carefully used, is best to remove most of the ink, but the erasing should be finished with a fine rubber used through a slot in an erasing shield. A good thing to restore the gloss is a broad pointed flat crayon or pencil, of the substance variously called French chalk, soapstone, or talc. The harder variety should be used, and the end of the crayon should be shaped flat on one side like a carpenter's chisel, so as to have a bearing area on the part used about ¼ x ⅜ in. By rubbing the spot on the tracing long enough at a moderate pressure, a gloss will be produced. The amount of pressure must be learned by experience, for if it is too much it will fail to produce a gloss. Care must be taken to have both the crayon and the tracing scrupulously clean or it will soil the spot erased. For cleaning tracings previous to inking I have found a dust bag made of fine, thin muslin filled with powered talc the most convenient thing to use. The bag should be made of a single piece without seams, just gathered to a neck and tied with a string. To keep it clean it should be kept in a round box with a cap cover.

For removing particles of foreign substance from the eye, a quill tooth pick is one of the best things I have found. The point should be slightly rounded and scraped smooth. A peculiar advantage of the quill, is that the point is almost as good as one of steel and it is flexible so that it springs somewhat when it touches the eye-ball which makes it much less liable to do injury if the eyeball moves when touched. The flexibility also adapts it well for scraping over the surface to remove particles slightly imbedded. One difficulty about shop eye doctoring is that so few will or can hold the eyeball steady, but I find in my own case that the only way I can do so, is to look steadily at some stationary object and by a firm effort of the will keep my eyes fixed on it. Until I learned this trick I did not known how to hold the eye steady; any-

one will be able to do so if these instructions are followed.

Some are troubled by the dash used between figures of feet and inches on drawings, because a dash is also the minus sign. In one drafting room where I worked they overcome this objection very simply by giving the dash a slight double curve something like two parenthesis marks joined end to end with one end curved up and the other down. This is easy to make and will not likely ever be mistaken for anything else.

In a description of filing jigs at page 434, Vol. 28, Part 2, the writer deplores the damage done to the files when they come down to the hardened stop plates.This can be avoided in most cases by using rollers mounted at the ends in bearings in place of the plates at only a slight addition to the cost. The rollers need not be hardened unless a great amount of filing be done on the jig if made of ordinary tool steel without amealing. If hardened, they should be draw-filed lengthways with a coarse file so that the teeth of the file used on the jig will catch and turn the rollers instead of slipping on their smooth hard surfaces.

At page 806, Vol. 28, Part 2, reference is made to the use of high explosives to start a gas engine, and editorially you express a preference for compressed air for the purpose, which preference I believe there is good reason for.

I was once employed in a steam engine shop, while they were experimenting with a new design of gas engine, their first experience with a gas engine. It was a two cylinder tandem double acting engine, too large to start by hand. It was built from designs furnished by some outside party, and one of the cylinders was provided with a starting plug at each end, in which gunpowder was to be exploded by a percussion cap, to start the engine. When it was ready for starting, in the testing room, there was no experienced man to start it, and so the erecting foreman was caled on to boss the job. When all was thought to be ready a charge of powder was put in to start it, and fired, but it failed to pass the center. A larger charge was fired but still it refused to go. The foreman then gave it another liberally increased charge and when fired it tore a chunk out of one side of the cylinder at the end fired, which piece just grazed the leg of the foreman, narrowly missed some of the bystanders and landed about 40 feet away.

This finished the experimenting on that engine and the most of it was consigned to the scrap heap. It is obvious that a "little compressed air" would have produced no such results and it shows how unsafe it is to use explosives for starting some gas engines, the majority of which are put in charge of inexperienced men.

Laying Out Bolt Circles.

In making plans for piping, flanges, etc., where many bolt holes are used, I made the template shown in the accompanying illustration, which greatly facilitates the work of laying out. Fig. 1 is for 4, 8 and 16 hole layouts, and Fig. 2 for 3, 6 and 12 holes, which cover all of our

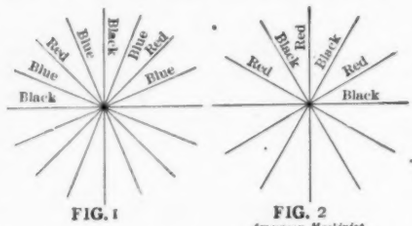


FIG. 1 FIG. 2
American Machinist

TEMPLET FOR BOLT CIRCLES.

work. After the flange diameter and bolt circle are struck, instead of spacing around the circle with the dividers or laying out with triangles, simply slip the templet under the tracing cloth and draw the bolt holes at the intersection of the radial lines of the templet and the bolt circle. In order that the eye will more quickly catch the division wanted, the various layout lines are drawn in different colored inks. Templets for other layouts can, of course, be made to suit requirements. The diameter of the circle may be large enough to suit the largest flanges used; 4 inches is about sufficient for almost all work when drawn to the usual scales. Although but a simple thing, this device saves much time when one has a number of layouts to make.

WM. C. MCLEOD.

Lathe Design and Practice.

As to Mr. E. H. Fish's rejoinder at page 63 regarding wearing surfaces for lathe cross slides, it would seem sufficient to say that we have the lathe illustrated in the *Machinist* in 1889 which has been in use for twenty-three years and the cross slide has never been refitted, and while not in perfect condition, it would have been had the wearing surfaces been set farther back and as it is the handle is not noticeably farther out in front than others.

Mr. Fish's drawings show badly, simply because he has put the wearing surfaces altogether too far in front.

The lathe is used a great deal more with the tool near the center than for large diameters and if there is a solid bearing under the point of the tool when turning the full size of the face plate, and if there is a solid bearing under the boring tool that is just as rigid when new as if the bearing were farther out or in and a good deal more so when unequal wear has taken place, in other words, if a tool has a traverse of 16 inches and the sliding surface is 20 or 21 inches long and properly located, it will be just as solid as if 40 or 42 inches long and with the short guide and long slide they will always fit and not get so bad as to need refitting every two or three years.

There was one thing I was in error about in my criticism of his slide rest, namely, the taper attachment. One with the extra slide is best, for, in the style I suggested, the slack in the screw renders it necessary to start at the large end of an external cone and at the small end of a hole, whereas with the extra slide there is no loss motion and the cut can be taken either way.

JOHN E. SWEET.

The Cutting Capacity of Power Presses.

At page 849, Vol. 28, Part 2, Mr. R. Shaw finds some objections to the correctness of the conclusions I arrived at in an article under the above heading; stating that the formula for the pressure $P = .5t^2 \cot \cdot s$ is not correct.

I beg to say that Mr. Shaw is mistaken. The difference in the result which Mr. Shaw obtains in figuring the work, is due to the fact that he uses in one case—with parallel knives—the factor p, while in the other—with inclined knives—he does not.

To show that both formulas agree exactly, we will leave this factor out of consideration in making the comparison and the result will be alike in both cases.

I will use the same examples and figures Mr. Shaw has chosen, although he uses the extreme thickness to which I went.

In the first case the work is

$$A = .5l\,t^2 \times \tfrac{t}{2}s$$
$$= 16 \times 1 \times 27 \times \tfrac{27}{2}$$
$$= 216 \text{ inch-tons.}$$

In the second case

$$A = .5\,t^2 \cot \alpha \times s \times 2t$$

in which $2t$ stands for the stroke of the upper plate giving:

$$A = .5 \times 1 \times 8 \times 27 \times 2$$
$$= 216 \text{ inch-tons as before.}$$

It is evidently the factor ½ which misled Mr. Shaw. It is contained in the factor for the depth of penetration as I gave it. I admit, however, that matters would have been clearer had I kept it separate.

That the factor ½ must appear in the first formula will be clear if we consider that the pressure is always proportional to the area under the knife, or the pressure will decrease from the maximum when the knife strikes the full section, to nothing at the end (theoretically).

That I did not use a factor similar to p to modify the pressure in connection with the formula $P = .5 \cot \alpha\, s$ is justified, as in my proof regarding the number of high points of a die it is of no consequence whatever, and within the range of thickness to which I have limited myself it is so near the unit as to be negligible in figuring the pressure.

E. W. ZEH.

Drawings as an Element of Cost.

Referring to article at page 95 by W. G., on the above subject, I am prompted to inquire just how W. G. would assign the cost of designing and of drawings to standard machines produced, were we to consider the draughtsmen as producers.

R. T. F.

I was very much interested in the article under the above heading by W. G. at page 95. I have come in contact with several systems of drawing cost keeping but most of them are along the plan W. G. writes about. The plan that struck me as good as any I heard of is this:

When drawings are made for special machines or attachments, they are charged up to the cost of these special machines or attachments. But when a machine is designed as a standard product, it is the practice to make an experimental machine first; the costs of making the design and drawings are figured in, in the total cost of this experimental machine and I think this is a good practice. If there are any changes to be made in the design after the experimental machine is built, the cost of making them is charged up to the first lot. It is the custom to make new blue-prints for every lot and these are figured in the shop costs of the respective lot of machines, also any further alterations or improvements are charged up to the lot in which the change takes effect.

H. I. C.

A Belt Puzzle.

In the belt puzzle published at page 62, it looks as though the supporting strips are at the root of the trouble. While Mr. Schumacher does not so state specifically, yet it is a fair inference that the strips are placed under all the double belts, but not under the single return belts—a reference to his sketch will show that from the receiving to the delivery end are seven traverses of the double belt, in four of which *d* is the under belt, riding on the strips, and in three *b* is next the strips. Three of *d* are thus neutralized by the three of *b*, meaning practically that belt *b* is running free while the other is being dragged over a long board. Now a strip of wood ten feet long pressing against a belt makes a pretty effective brake—as the strip has a two-inch rise in the center and the belt is under heavy tension, the pressure is by no means light. Of course this brake may be said to act also on *b*, but it is proportionately ineffective, since when *d* overcomes the brake friction, *b* resting on *d* will travel with the latter unless there be some retarding influence.

When the power is applied to rolls *a*, belt *b* being on the outside and therefore running on the largest pulley, should and does travel the fastest, and being driven through belt *d* the brake can have no effect on their proportional speeds. When rolls *c* act as drivers, belt *d* should be the fastest running, but here the brake, acting on *d*, reduces its speed until the friction between the two belts equals or slightly exceeds that between belt *d* and the brake. When both *a* and *c* are drivers, the combination should produce an equal speed in the belts, but here again is seen the influence of the brake, with the same effect, that belt *d* is the slowest traveler.

I would suggest applying a strip under the single return belt *b* to equalize the brake action, and apply power to all the rolls; that the two belts may be on the same footing as driving power.

It should not be overlooked, however, that the two belts must continually slip upon each other or upon the pulleys, as a momentary inspection will show that each belt passes alternately over a large and a small pulley, both rotating at the same speed. It will therefore be exceedingly difficult to obtain the desired uniformity of travel, perhaps impossible, as this slippage will undoubtedly vary at intervals.

C. W. PITMAN.

[The same solution is offered by a contributor who signs himself "W."—Ed.]

In the letter "A Belt Puzzle," at page 62, Mr. Schumacher does not make one point quite clear. If he means to say that if he moved those rolls by hand enough to make a mark on belt *d* travel one foot while another mark on belt *b* in the same time traveled thirteen inches, or "a gain of one inch in each running foot," I should be tempted to do like the editor and leave it for some one else to solve. If, however, he allowed the belts to make one complete round on the machine and after measuring the distance between the two marks averaged up the result and found same to be "a gain of one inch in each running foot," then the proposition is an entirely different one and the solution is simple.

A rough measurement of the sketch would indicate that belt *b* was about 92 and belt *d* about 100 feet long, which would leave a difference of eight feet, or 96 inches between the two belts. Allowing for the inaccuracies due to measuring the sketch with a rule and estimating the curves in the belts, this result might easily be changed enough to make the total result equal one inch to each runrung foot of belt. For instance, if belt *b* is actually 92 feet long and the difference between that belt and belt *d* was exactly 92 inches, then the total average would be exactly that found by Mr. Schumacher. As this would only show a change of four inches in my measurements, I am inclined to think this is the solution of his trouble. Another reason that makes me think this is the correct understanding of Mr. Schumacher's explanations, is that he writes of the conveyor as if same were in successful operation, which I do not think would be the case if his belts actually slipped, one on the other, at the rate of one inch per foot, as in traversing that seventy odd feet of double belt the slip would be approximately six feet, which would be apt to cause trouble with the envelopes.

L. L. ARNOLD.

Referring to the belt puzzle at page 62, I beg to suggest that the action is probably due to the relation of the hair and flesh sides of the belts to each other. It would probably be found that the belts slide more easily on each other in one direction than in the other so that by changing their relative positions it would probably be found possible to make belt *d* go faster than belt *b* or perhaps at the same rate.

M. E.

Proving Addition, Subtraction, Multiplication and Division.

From time to time communications have appeared in your columns on the subject of proving addition, subtraction, multiplication and division by the "check figure" system, and in most instances the writers have endeavored to convey the impression that such systems are of commercial value. I wish to take exception to such a position, practical experience with check figure systems having led me to discard them as worthless. I am fully aware they are in extended use, and are regarded as infallible by many, but I hope to show by an example of the simplest sort that they are very fallible indeed.

Let it be desired to add 123 to 234. The operation would be:

123	6	
234	9	
357	15	6

In this instance the check is 15, or, if reduced to one digit, 6. The sum of the two check figures, 6 and 9, and the check of the sum 357 are equal, but this does not prove that the operation has been correctly performed. Suppose the addition had been performed in this manner:

123	6	
234	9	
537	15	6

The sum 537 is clearly an error, but the check figures fail to detect it. A simple transposition of the digits is evidently sufficient to destroy the value of the check.

It is unnecessary to give examples in multiplication and division, for if the system will not bear examination in the simple arithmetical process of adding two quantities, it surely will not stand the strain of more complex operations. The best to be said for the check figure system is that if the result of the operation performed with the check figure agrees with the check figure of the arithmetical

result the calculation is *probably* correct—nothing more. As a means of reducing the drudgery of arithmetical processes it is untrustworthy and much over-rated.

JAS. W. MANSON.

Finding the Diameters of Shell Blanks.

At page 60, Vol. 28, Part 2, I published some formulas and a diagram for finding the diameters of blanks for drawn cylindrical shells. Considering that the practical man is handier in the use of the dividers than in drawing square roots, I give now another simple method for the same purpose and apply the same also to some other shapes which frequently occur in practice.

The method is based upon the surface of the shell in comparison with the area of the blank and should therefore be used only when light material is to be considered. In case of the flanged shapes the width of the flange should be small in proportion to the diameter.

Fig. 1 shows a cylindrical shell of the diameter d and the depth h. To find the diameter of the blank, we lay down the diameter d of the shell twice on a horizontal line, add to this a distance equal to four times the depth h of the shell and describe a semi-circle of which the total distance is the diameter. The vertical line D from the intersecting point with the circle to the horizontal line gives the desired blank diameter. Line D is to be drawn at a distance d from the end of the horizontal.

If the shell has a flange as in Fig. 2, we add four times the width of this flange to our horizontal line and proceed as above, see Fig. 4.

In the case of a hemisphere, Fig. 5, we lay down the diameter three times on our horizontal line and draw the vertical line at the distance d from the end, as in Fig. 6.

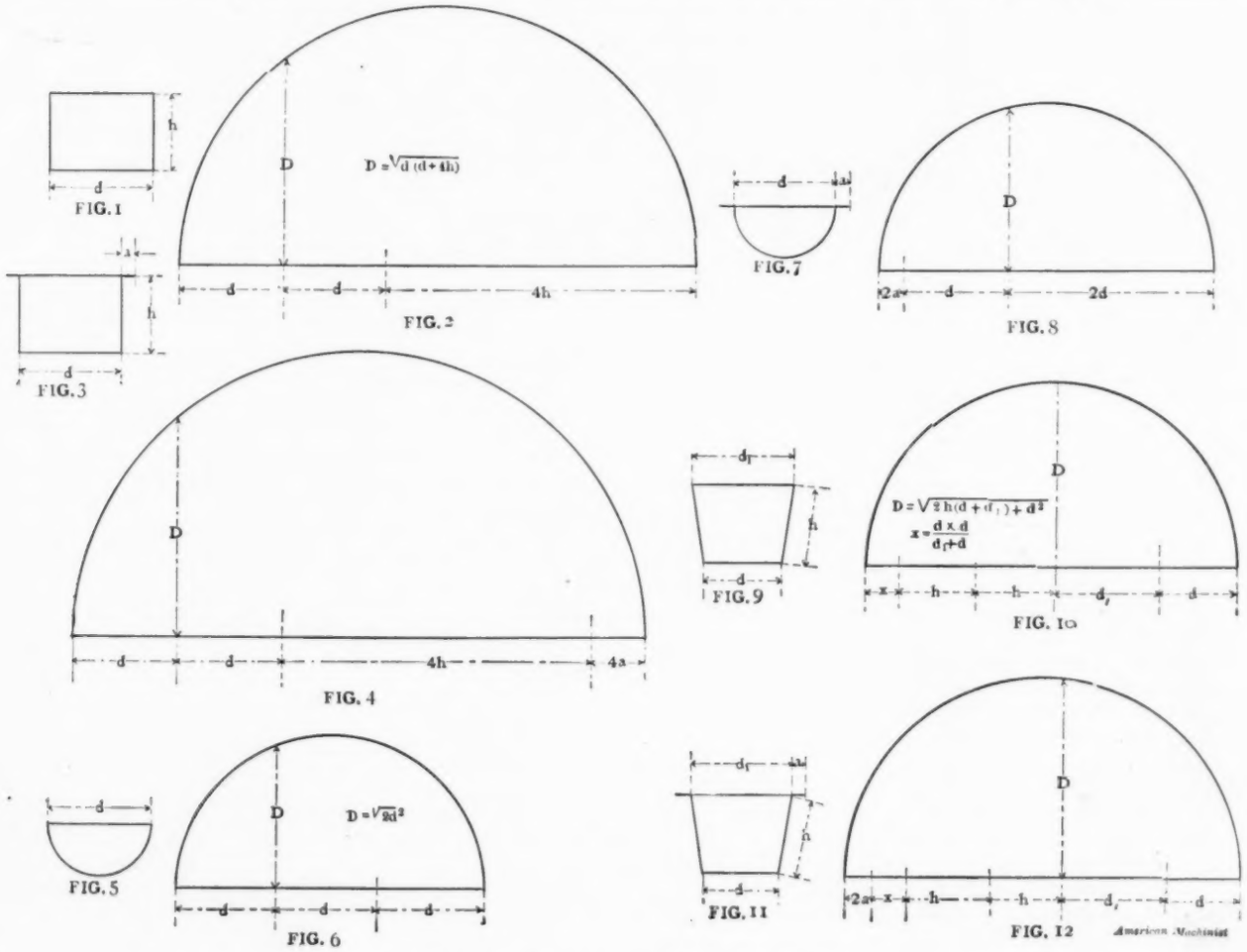
If the hemisphere has a flange as in Fig. 7, then we add a distance equal to twice the width of the flange to the horizontal line, as in Fig. 8.

In any case the length of the vertical line D gives the desired diameter of blank.

If a shell with tapering sides, Fig. 9, has to be drawn, we have to multiply first the bottom diameter by itself and divide the product by the sum of the two diameters d' and d in order to obtain the length x. Otherwise we proceed as shown in Fig. 10.

If the taper shell has a flange of the width a, Fig. 11, we add to the base line of the diagram twice this width, as shown in Fig. 12.

E. W. ZEH.



FINDING THE DIAMETERS OF SHELL BLANKS.

The Selection of Material for the Construction of Hydraulic Machinery.

Referring to the paper on the above topic at page 6, I think Mr. Falkenau is in error in stating that the press cylinders for raising the tubes of the Britannia bridge were finally made of wrought iron.

The fact is that a large press cylinder separated from its end. The press was rebuilt with cylinder of the same material, and with walls of same thickness as before, but "great care was given to the selection of proper iron to insure soundest possible castings."

It is evident the engineers at that early date saw the uselessness of exceeding a limited thickness in gray-iron cylinders, and possibly were assisted by the nature of the fracture to improve the shape where the end joined the cylindrical portion. Too much care cannot be given to uniformity of thickness of material. From a very long experience in the design of hydraulic cylinders of gray iron, I know that lack of this care has frequently had

more to do with failure than the iron; especially does this apply to cylinders with one end closed.

Another important matter is the choice of foundry and of methods used for this particular work. An inexperienced foundry with the best iron would probably turn out a bad cylinder. The founder is usually responsible for spongy cylinders, sufficient care not being given to the dryness of core or mold, to the venting to carry off the gases or to the equally important feature of a head of enough weight to compress the metal in the cylinder, and assist in destroying the possibility of percolation. That the wrought-iron cylinders expanded until the material took a permanent set sounds like a fairy story. The greatest load one cylinder had to carry was 1,144 long tons, which gave a pressure of approximately 8,000 pounds per square inch. The stress on the material at its inner circumference, calculated from Lamé's formula is 14,840 pounds per square inch which, while on the high side, it is very considerably below the elastic limit of the material. The stretch under the load would be measurable, but why should the cylinder not return to its original shape and follow the laws as we know them?

HYDRAULIC ENGINEER.

Cutting Square Holes in Gear Hubs.

We have at the factory a Morton keyseater which has not been in use for over two years as we have had no work for it, and being a large machine, and in good condition, we had to take some steps to put it in commission.

We have several thousand steel gears requiring a square hole in each which we had been slotting in a shaper but it seemed not stiff enough to get them out in a reasonable time. The accompanying sketches show an attachment to the Morton keyseater which has given splendid satisfaction for this work.

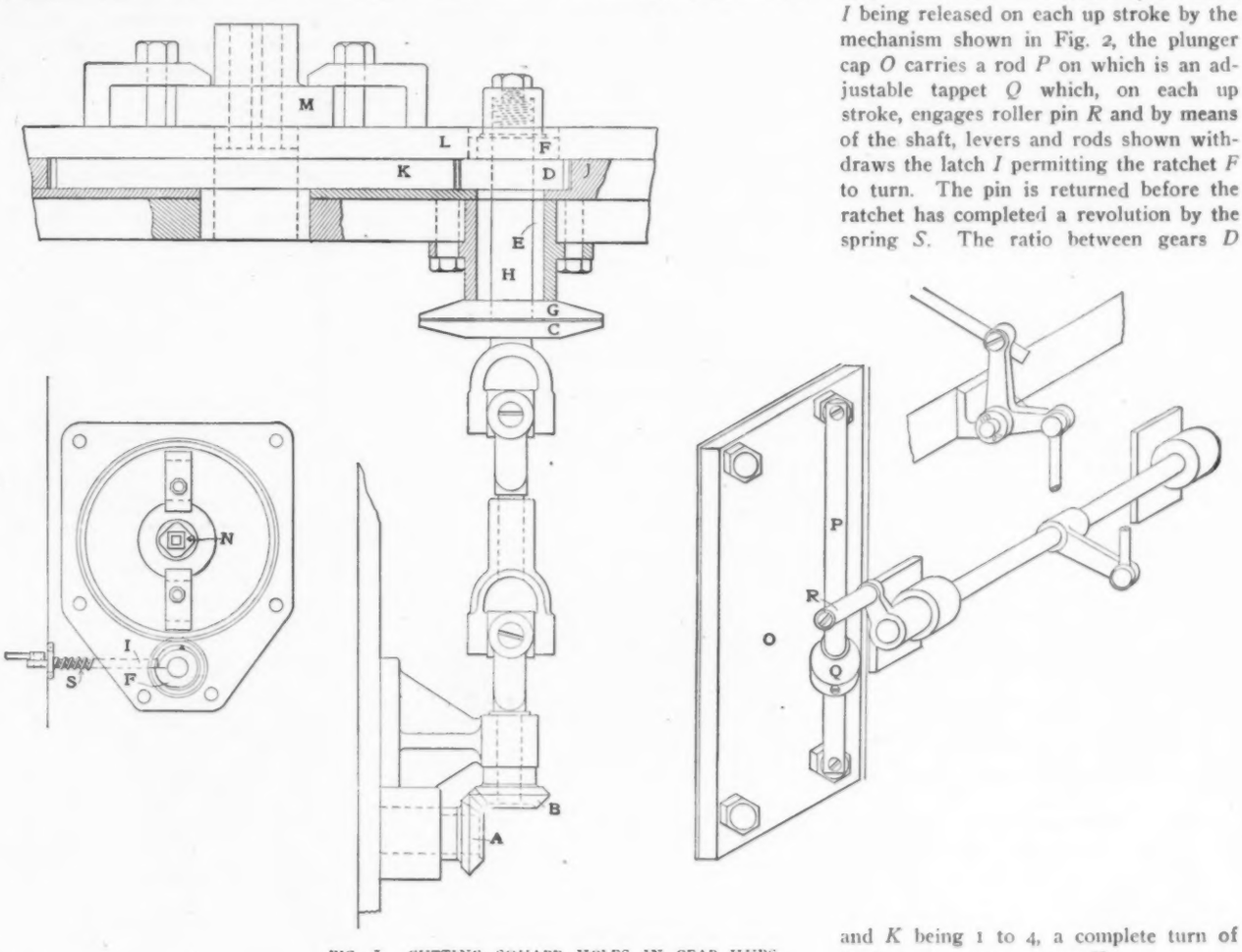


FIG. 1. CUTTING SQUARE HOLES IN GEAR HUBS.

A Fig. 1, is a bevel gear pinned to the end of the main shaft and driving gear *B* which, by the universal jointed shaft, drives the friction plate *C*. *D* is a gear integral with bushing *E* and having a single-toothed ratchet *F* (better shown in the plan view) on its upper face, *E* being screwed to the friction plate *G*. *H* is a bolt brazed to plate *C* and having a fiber washer and jamb nuts at its upper end by which the friction plates are made to compress a leather washer between them. It will be observed that plate *C* is in constant motion and tends to turn plate *G* and gear *D* which, however, it is prevented from doing by a latch pin, *I* in the plan view, acting on the ratchet *F*. A plate *J* is bolted to the table of the machine. Gear *D* and a gear *K* of four times the diameter of *D* are carried in recesses bored in plate *J*, *K* being supported by a bearing below and a second bearing turned on its upper face and fitting a hole in plate *L*. Gear *K* carries the work *M*, the cutter bar running up through the hole in its center as shown at *N* in the plan.

The cutter makes its cuts on the four sides of the hole in succession, the latch *I* being released on each up stroke by the mechanism shown in Fig. 2, the plunger cap *O* carries a rod *P* on which is an adjustable tappet *Q* which, on each up stroke, engages roller pin *R* and by means of the shaft, levers and rods shown withdraws the latch *I* permitting the ratchet *F* to turn. The pin is returned before the ratchet has completed a revolution by the spring *S*. The ratio between gears *D* and *K* being 1 to 4, a complete turn of *D* gives a quarter turn to *K*.

WM. THEIMER.

Cutting off Paper.

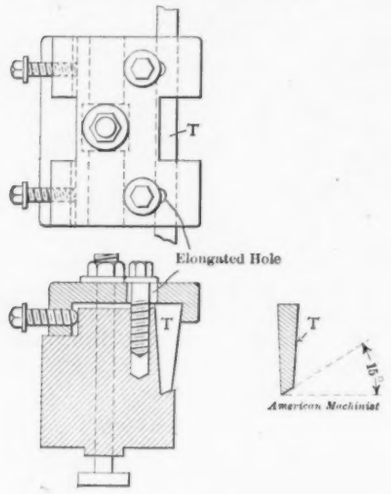
Referring to the article on cutting off paper at page 30, I should like to suggest a still easier and quicker method by the use of an old hack-saw blade sharpened on both edges. Lay the roll of paper on a table, measure off a standard sheet and mark it with lead pencil, fold the paper over, and mark another sheet off; then sharpen the edge from right to left, and use the hack-saw blade as a paper knife. By this means it is not necessary to use a rule for each piece.

I believe this to be a much quicker and easier method than the string and weight plan.

D. ALSTON.

Cutting-Off Tool Holder.

The enclosed sketch illustrates a cutting-off tool-holder used on the front side of a large Cleveland automatic screw machine. The holder and clamps are made of machine steel case-hardened.



CUTTING-OFF TOOL-HOLDERS.

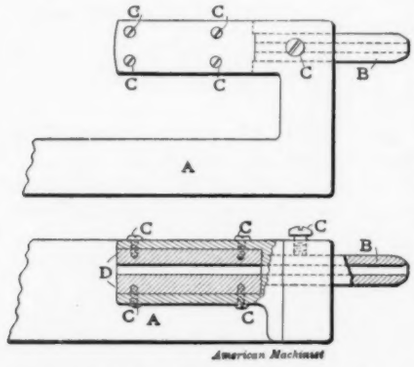
T is an end view of the blade or tool used, which is tempered and ground on a surface grinder on all sides its entire length, 9 inches.

The base of the tool is ground in a special fixture to an angle of 15 degrees and to a height that permits the tool to cut on center when clamped in the holder. The manner of clamping the tool in the fixture will readily be seen and needs no explanation.

To sharpen the tool it is ground only on the end, the top face always remaining as it left the grinder. CY PRESS.

Wire Guide for Winding Springs.

The wire holder and guide shown herewith will be found a very convenient and satisfactory tool where much spring winding from different sized wire is to be done. The first one I ever made was without the tension clamp, which was added on later ones. It will, however, be found well worth the extra trouble it takes to make it.



WIRE GUIDE FOR WINDING SPRINGS.

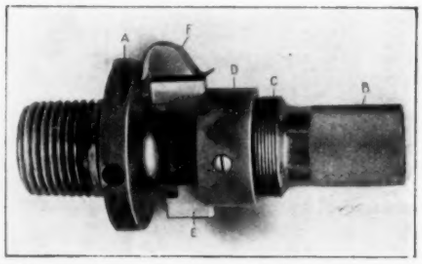
The shank *A* should be forged to shape, as shown, and after being smoothed up with a file may be quickly finished right in the lathe by holding it in the tool-post, and first setting it parallel with bed and drilling the hole for the bushing *B;* then setting it at right angles and drilling and milling (with an end mill) the slot for the hard fiber jaws *D*. Both the jaws and the bushing are held in place by screws *C*, as shown.

Bushings for different sized wire may be made in less time than it takes to tell it from ¼-inch drill-rod by catching in drill chuck in live spindle and drilling, pointing and cutting off. The mouth of the bushing should be rounded a little with a hand tool, and they may be hardened or not, according to the amount of use they are likely to get. When in use the tension jaws are brought together on the wire by a small C or parallel clamp, enabling one to get just the right tension. The bushing *B* projects about ⅜ inch from the end of the holder.

M. C. CONWELL.

An Arbor for Finishing Internally Threaded Work.

The photograph shows a very handy device to be used in the screw machine or lathe for finishing work which is already threaded internally.

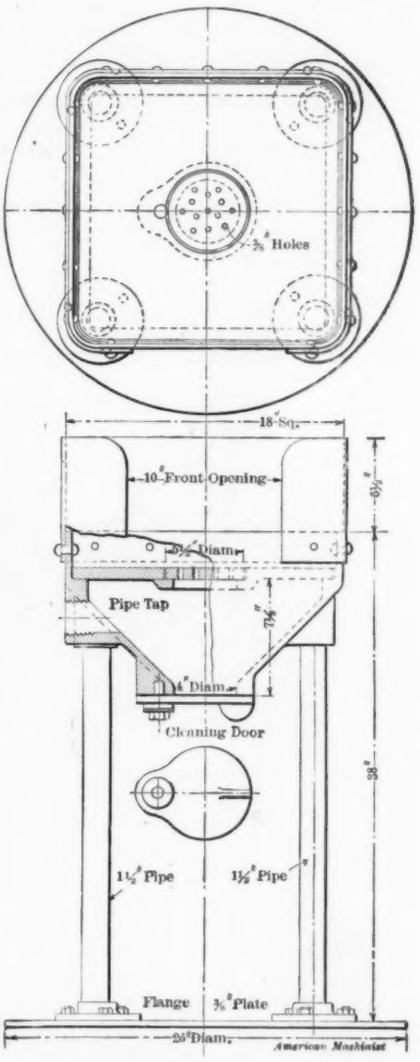


It provides an easy method of releasing anything that in the making is screwed on the arbor so hard that it is difficult (especially if it is round and nicely finished) to remove without marring, and its action is simple. The body *A* is threaded to receive the nurled sleeve *B* and the latter is externally threaded at *C* to suit the piece to be finished. Back of this portion is a movable sleeve *D*, with a key *E* behind it, which key has a slight taper the straight side being next to the sleeve. This key is normally kept in the position shown by spring *F*, thus forcing the sleeve out toward carrier *C*, and in this position the work is screwed on; when finished, a slight tap forces the key out and so relieves the piece which is then easily screwed off.

I have found this much the best of any thing that I know of for the purpose, it having great advantages over a collapsing plug, and for this reason I am anxious that the craft should know it. As someone has said, "We pass this way but once, so let us do what good we can." P. A. WHITNEY.

A Forge for Heating Rivets.

The accompanying sketch shows the construction of a very handy, inexpensive and efficient portable rivet-heating furnace. Many of these furnaces have been built for the use of a firm of locomotive builders, and I believe they now have about fifty of them in constant use in their tank shop, where the locomotive tenders are constructed. The furnaces are installed on the battery system—that is, for each pair of tenders on the erecting floor there is immediately in front of them one of these heating furnaces capable of heating rivets fast enough for the construction of the two tanks at once. This system is continuous throughout the entire length of the shop, which accommodates about ten pairs of tanks at a time. Over the furnaces is a 12-inch exhaust fan system with an 8-inch branch pipe and a 24-inch-square hood running down to within 18 inches of the top of the furnace.



A RIVET-HEATING FORGE.

The smoke and gases are taken care of very successfully in this manner and the shop is kept very clean. In the boiler shop, where the atmosphere is not so clean

—on account of the numerous open forge fires in operation—the smoke and gas exhaust system is not used.

Burning pea coal these furnaces are heating rivets from ⅜ to 1⅛ inches in diameter with the greatest satisfaction. In the side is the entrance for the air blast from a continuous underground system to all the fires and forges in the shop. The main body casting is of gray iron fitted with a false bottom and grating; at the bottom of the air chamber is a small cleaning door. Around the rim of the body is riveted a 10-gage sheet-iron band 8 inches wide, forming the fire-box; there is a 10-inch opening on one side for handling the rivets, etc. The four legs are of 1½-inch pipe screwed into bosses on the body casting; the bottom end of the pipe is screwed into 1½-inch standard flanges, which are bolted to a piece of ⅜-inch boiler plate 26 inches diameter, making it possible to move the furnace as a unit, the plate also serving to catch any red-hot coals that may fall during the cleaning operation. BAYARD.

California.

A Pawl Feed.

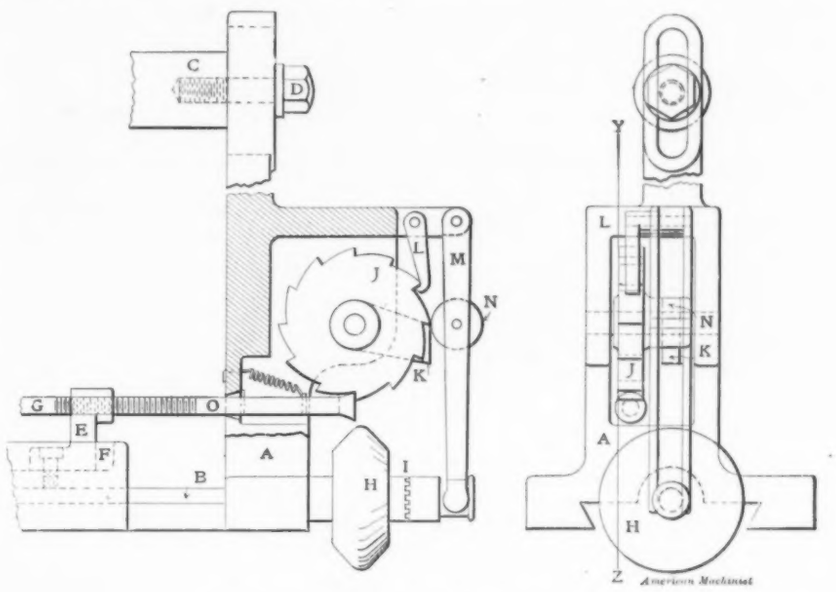
I enclose sketches of a pawl feed which I think is rather a good one, and hope it will interest your readers. It has a great advantage over the ordinary toothed ratchet wheel, especially on a machine where several different feeds are required, which as a rule necessitates the changing of the ratchet wheel for one with a different pitch. Not so with this one; by adjusting the connecting rod lever that is worked from the cam shaft, a very fine adjustment can be got on the main feed rollers of the machine. I have fitted several of these on machines that are cutting off sixty to seventy pieces per minute, with plenty of vibration, but they do not slip, nor does the work vary in length in cutting.

Figs. 1 and 2 show sections of the wheel and guides. Fig. 3 shows the position of the pawl, and the connecting rod for operating it. Care should be taken to set the pawl absolutely on the center, or else it will slip. It is of cast-steel hardened, and the rear end works in the brass shoe and not on a pin. P. H.

London, England.

A Knock-Off for the Automatic Gear Cutter.

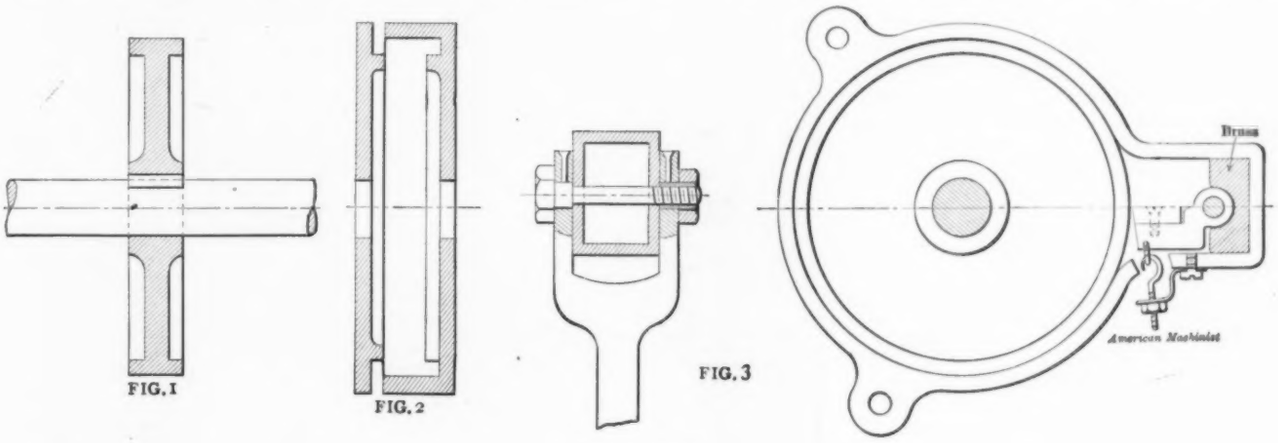
The problem was to cut a limited number of teeth in a wheel through only a part of its circumference, on the automatic gear cutter, without danger of cutting farther than desired. The number of teeth in the different wheels varied, running from five to eleven. The attachment shown in the drawing proved a very satisfactory solution, and is being used constantly. It is attached to a Becker & Brainard automatic gear cutter, though no doubt the same attachment, with the necessary modifications, could be used on any other make of machine.



KNOCK-OFF FOR AUTOMATIC GEAR-CUTTER.

Bracket *A* is mounted on guide *B* of the machine, and extends to overhanging arm *C*, to which it is clamped by screw *D*, as shown. The slot in the bracket *A* is made of a length to allow the required vertical movement. Bracket *E* is bolted to carriage *F* and carries rod *G*, which is threaded, making it adjustable. *H* is the gear case, and *I* is the clutch at the end of the carriage screw. Bracket *A* contains the ratchet wheel *J*, which has a cam *K* on its hub, set a convenient distance from the wheel proper, as shown in the end view. The pawl *L* and the lever *M* are pivoted to an arm on bracket *A*. Lever *M* is made of two flat bars of steel —a bar on each side of the supporting arm, as shown in the end view. Between these bars roller *N* is pivoted, so that it turns freely. The bars extend to clutch *I*, and any outward movement of lever *M* will tend to open the clutch.

Rod *O* has a tapered head, and extends through a hole in the bracket *A*. This hole is conical, so as to permit an up-and-down movement of the rod, and through the latter is a pin which acts as a stop against the bracket, and thus prevents the tapered head from going farther



PAWL FEED.

back than the center line of ratchet *J*, this position being considered the best for engagement with the ratchet teeth. The spring, which is attached to rod *O* and bracket *A*, is placed at an angle so as to give both a backward and upward pull to the rod. Rod *G* is adjusted so that the return of the carriage will move rod *O* just far enough to cause pawl *L* to fall into the next notch. The sole purpose of this pawl is to keep the ratchet wheel from running backward. If five grooves are to be cut, the cam *K* is set five of the notches on the ratchet wheel ahead of the roller *N*. Each time the carriage returns the rod *G* strikes the rod *O* and turns the ratchet *J* one tooth. The sixth time the carriage returns the cam *K* comes under roller *N* and throws out the lever, thus disengaging the clutch and stopping the carriage. The operator then removes the work, replaces it with a blank, resets the cam, and the operation is repeated. There can be no danger of cutting more than the required number of teeth. It is obvious that the number of teeth in the blank to be cut cannot exceed the number of notches in the ratchet. L. F. B.

Worcester Polytechnic Institute.

The Board of Trustees of the Worcester Polytechnic Institute has decided to proceed immediately with the erection of a large building which will be used exclusively for the purposes of an electrical engineering laboratory. This subject has been under consideration for some time and the recent rapid increase in the number of students has finally brought about so congested a condition of affairs that relief of some kind became necessary.

An important feature which will be kept in mind in connection with the new building will be a laboratory for the uses of the department established last fall in electric railway engineering. The Worcester Institute is one of the three or four institutions in the United States which now maintain such a course, and it is the only institution in the country which has established an independent professorship in electric railway engineering.

The quarters now occupied by the Electrical Engineering Department will be placed at the disposal of the Department of Physics and of Chemistry, and will afford to each of these a much needed relief.

L. L. CONANT.

The "Carmania."

Owing to a typographical error at page 857, Vol. 28, Part 2, the horse-power of the "Carmania" was stated as 2,000. This should have been 20,000. Even the latter is only an approximation, for as yet her actual power is not known precisely.

A man never improves if he looks into a looking-glass for his model.

The Automobile Testing Plant of Purdue University.

Purdue University, Lafayette, Indiana, about fourteen years ago became distinguished in the railroad world by installing the first plant for making tests indoors upon locomotives, under actual running conditions, with the advantage that these conditions could be controlled and ac-

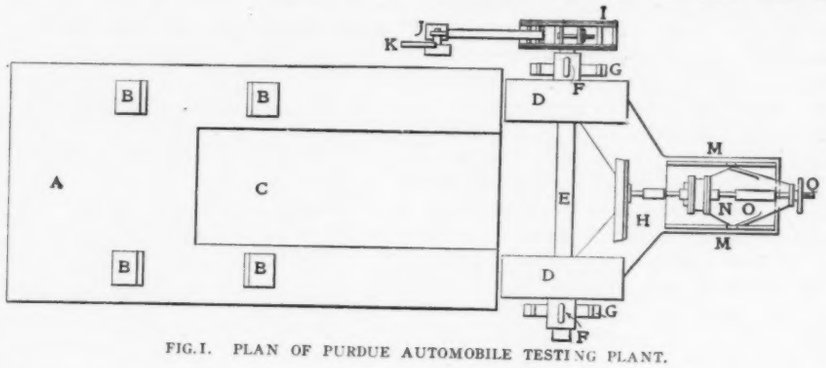


FIG. 1. PLAN OF PURDUE AUTOMOBILE TESTING PLANT.

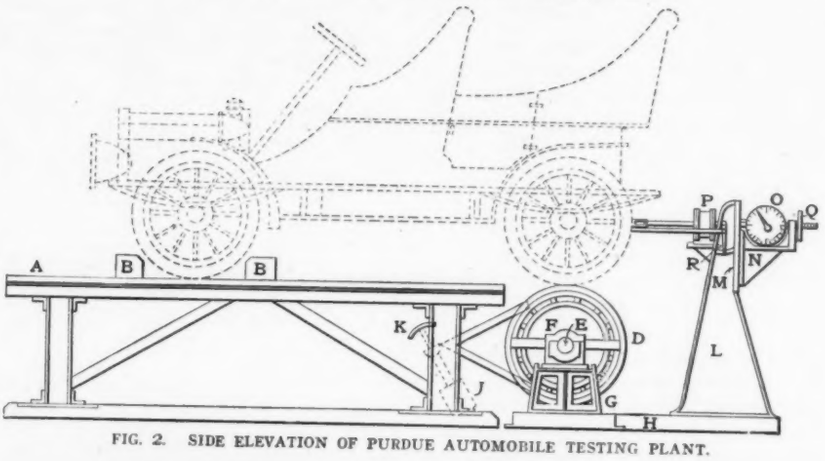


FIG. 2. SIDE ELEVATION OF PURDUE AUTOMOBILE TESTING PLANT.

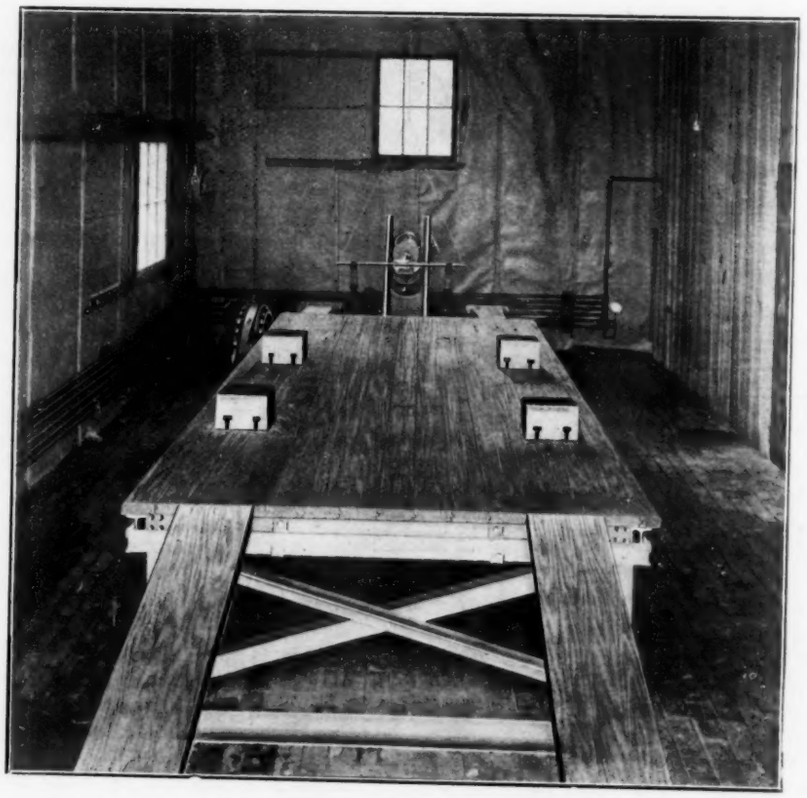


FIG. 3. VIEW OF TESTING PLANT, LOOKING TOWARD TRACTION DYNAMOMETER.

curately measured, thus enabling scientific tests and comparisons of different locomotives to be made, and much data to be obtained which it would be difficult or impossible to obtain from locomotives running on the road. A number of plants on similar principles have since been constructed, the best known probably, on account of the publicity incident to its location, being that of the Pennsylvania Railroad at the Louisiana Purchase Exposition. The rapidly growing importance of automobiles as a means of transportation, the continual increase in the size and power of these vehicles—and, we might also say, the tremendous increase in the consumption of gasoline, in proportion to the available supply—make it more and more important that economy and efficiency should be studied in their design, and the extension to the automobile of testing plant facilities similar to those its big brother has for several years enjoyed, is, though a far less ambitious undertaking, the logical sequence of the testing plant for the locomotive. Such a testing plant has been installed by Purdue University, and illustrations and a description of it are presented herewith.

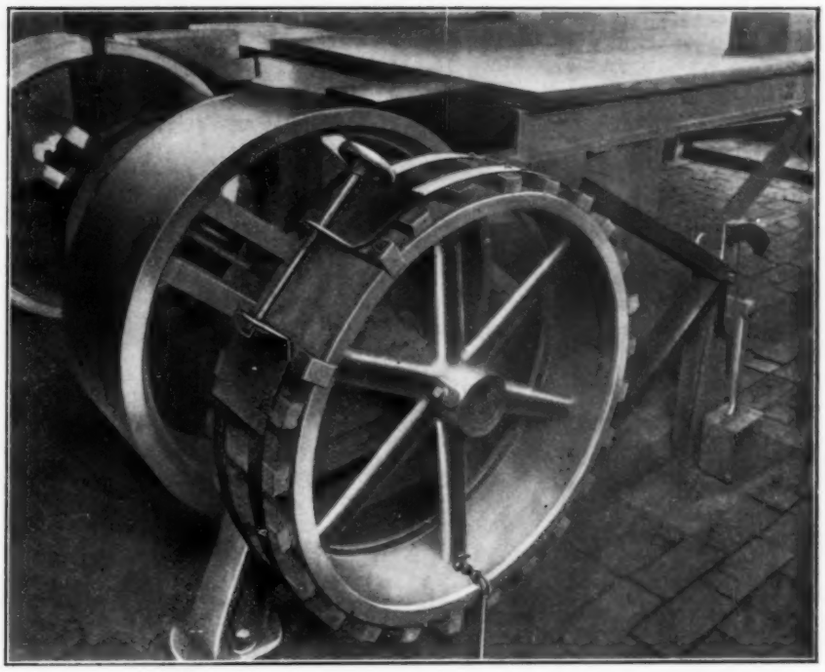


FIG. 5. SUPPORTING WHEELS AND FRICTION BRAKE.

The design of the plant has been worked out under the general direction of Dr. W. F. M. Goss, Dean of the Schools of Engineering, assisted by Professors J. R. McColl and W. O. Teague. It follows lines which are similar to those of Purdue's locomotive testing plant. It constitutes a mechanism upon which an automobile of any type, whether steam, electric or gasolene-driven, may be mounted and operated. When thus operated the power delivered and the efficiency which marks the action of the machine may be determined. A plan and elevation of the plant are set forth by Figs. 1 and 2. By these it will be seen that an automobile mounted for testing has its driving wheels carried by the supporting wheels of the plant. These wheels are upon an axle which revolves in fixed bearings. Thus mounted, the automobile is held in its desired position by a connection with a traction dynamometer which, in Fig. 2, appears at the rear of the machine. A friction brake on the axle of the supporting wheels absorbs the energy delivered by the machine. A motor driven pressure blower delivers air through adjustable piping for cooling the radiators of steam and gasolene machines, and a motor driven exhauster takes air from a point near the exhaust of the machine, thereby freeing the laboratory of obnoxious gases.

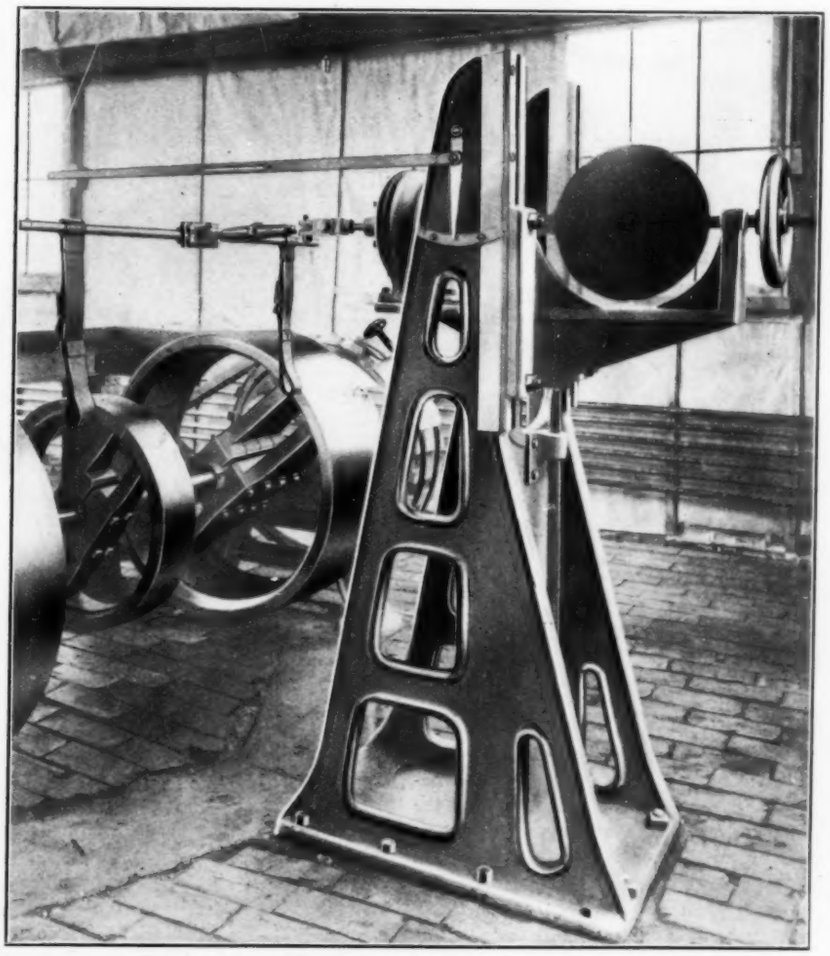


FIG. 4. TRACTION DYNAMOMETER AND ONE SUPPORTING WHEEL.

Concerning the theory of action, a glance at Fig. 2 will make clear the fact that if the supporting wheels were blocked so that they could not turn, the automobile would, if started, tend to move forward with its full tractive power even to the extent of slipping its wheels upon the supporting wheels. Its tendency to move forward in this case will be registered as a pull upon the dynamometer. If, on the other hand, the supporting wheels are frictionless, then the turning of the wheels of the automobile through the action of its machinery will not result in any pull upon the dynamometer, for if frictionless, the supporting wheels can offer no reaction for such a pull. The supporting wheels are, in fact, neither blocked nor frictionless, but the

design is to have them turn against a resistance the value of which may be varied at will. The arrangement is such that whatever this resistance may be it appears as a stress on the draw-bar. The resistance is regulated by means of a friction brake to which reference has already been made. By its adjustment the automobile may be made to pull little or much upon the dynamometer, that is, it may run under a light or a heavy load as may be desired. In all cases the energy delivered by the automobile is the product of the pull exerted at the draw-bar, into the distance passed over by the tread of the driving-wheel. Thus, the horse-power delivered is equal to the pull upon the dynamometer in pounds, multiplied by the space passed over in one minute by the automobile driving wheel, divided by 33,000. The space passed over is most conveniently found by determining the number of revolutions of the supporting wheel since the latter is of fixed diameter; that is, the determination is based upon the length of the path traveled rather than by the rate of revolution of the driver.

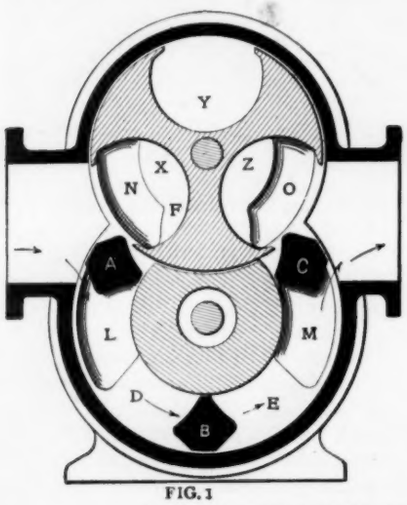


FIG. 1

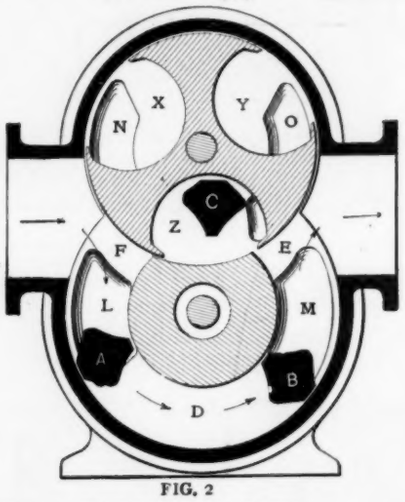


FIG. 2

DIAGRAMS ILLUSTRATING ACTION OF HIGH PRESSURE BLOWER.

Fig. 3 is a photograph of the plant with automobile removed, looking toward the dynamometer. Fig. 4 is a partial view of the opposite end showing the traction dynamometer and Fig. 5 shows the supporting wheels and the friction brake.

While the plant will lend itself to studies of a highly refined character, it is proposed during the present winter to determine the output of power under various conditions of running of a considerable number of typical machines.

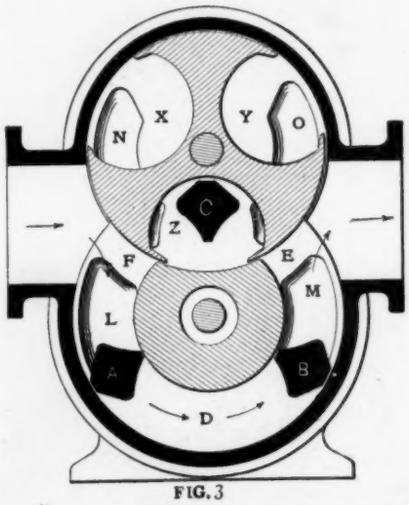


FIG. 3

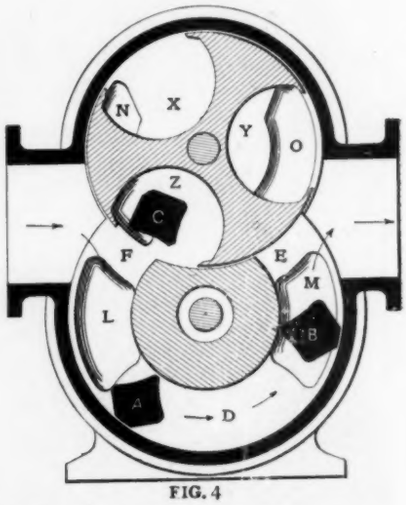


FIG. 4

DIAGRAMS ILLUSTRATING ACTION OF HIGH PRESSURE BLOWER.

Two shots from the Brown six-inch wire gun attained a muzzle velocity of 3,410 feet a second—the greatest velocity ever obtained from any gun of equal caliber—at the government proving grounds at Sandy Hook, January 27. Fourteen rounds in all were fired under the supervision of Col. Charles S. Smith, United States Army. Up to date eighty rounds have been fired at the proving grounds from the Brown gun.

The Sturtevant High-Pressure Blower.

CONSTRUCTION.

The Sturtevant high-pressure blower is made in two types: in the horizontal, the two shafts lie in a horizontal plane, while in the vertical one shaft is above the other. The latter is the one illustrated herewith. The blower, shown diagrammatically in Figs. 1 to 4, consists of a cast-iron shell or housing (Fig. 8) in which are two rotating members or "rotors." One of these, the impeller (Fig. 9), revolves in the larger portion of the casing which in the vertical type is the lower. It does the real work of compression. The other rotor, known as the idler (Fig. 10) does no work; it successively provides spaces or chambers of proper shape at the desired points in the revolution, so that the impeller blades may return to the suction side of the blower without allowing the escape of compressed air.

Ample clearance between the rotating members and the casing insures high mechanical efficiency by absolutely preventing internal friction due to contact of mental surfaces. Between the idler and the impeller the space is so great that only excessive variation in the accurate running of the gears will allow the two rotors to come in contact. This clearance is at least one-eighth inch in small blowers and in large sizes, one-half to three-quarters inch.

The idler, or drum (Fig. 10), revolving in the smaller part of the casing, which in the vertical type is above the impeller, is symmetrical and has a periphery nearly a complete circle. It consists of three hollow vanes or blades cast in one piece with the shaft which is of cast iron, very rigid, and of ample strength to transmit the little power necessary for rotation. The idler, revolving with large clearance, is turned at the same speed as the impeller by means of two spur gears (plainly seen in the longitudinal section, Fig. 5) running in oil and incased for protection against dirt and accident.

The impeller (Fig. 9) mounted on the driving shaft, is made up of three diamond-shaped bars or blades and a central web which is keyed to the steel shaft. Being symmetrical it is perfectly balanced at all speeds. As it revolves three separate pockets are formed in the annular space between the shell and a core (Fig. 11) extended lengthwise of the lower part of the casing. In reality the core is in two parts, each cast in one piece with the end plates, the space between them allowing the web to revolve.

The cast-iron shell or casing (Fig. 8) consisting of two hollow cylinders partially intersecting, is accurately bored and amply strong and rigid to withstand the strains due to handling, setting on foundation, and operation at high pressures. The ends of the casing are finished to receive the four cover plates (Fig. 7) in which are cast chambers or passages for lessening the noise, and increasing the efficiency of the machine, as is explained under "operation." On either side of the housing are openings for the intake and

the discharge of the air, flanged and tapped for standard gas pipe fittings; the small sizes have openings at the sides, and the large blowers openings at the top and bottom. In every respect the casing and rotors are symmetrical, permitting the blower to run in either direction.

Except in blowers of large size, the lower half of each journal box is cast in one piece with the cover plate (see Fig. 7), insuring rigidity, simplicity and correct alinement. The boxes, except those for very small blowers, are of the ring-oiling type, lined with Sturtevant white metal, hammered in, and accurately bored.

When it is desired to maintain absolutely constant pressure, the blower is provided with a relief valve, or automatic

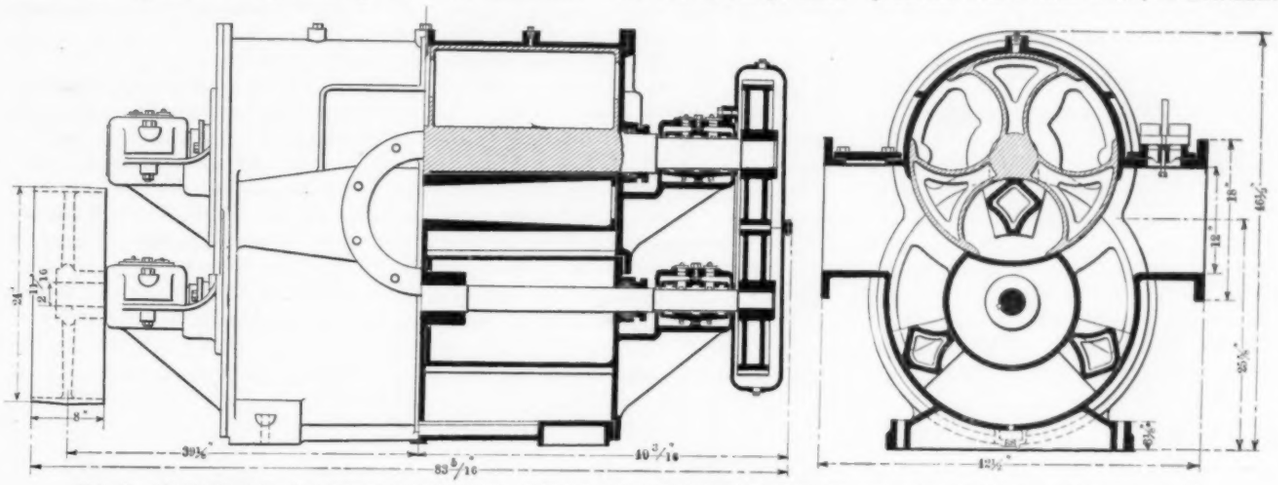


FIG. 5. HALF ELEVATION, HALF LONGITUDINAL SECTION, AND TRANSVERSE SECTION OF HIGH PRESSURE BLOWER NO. 8.

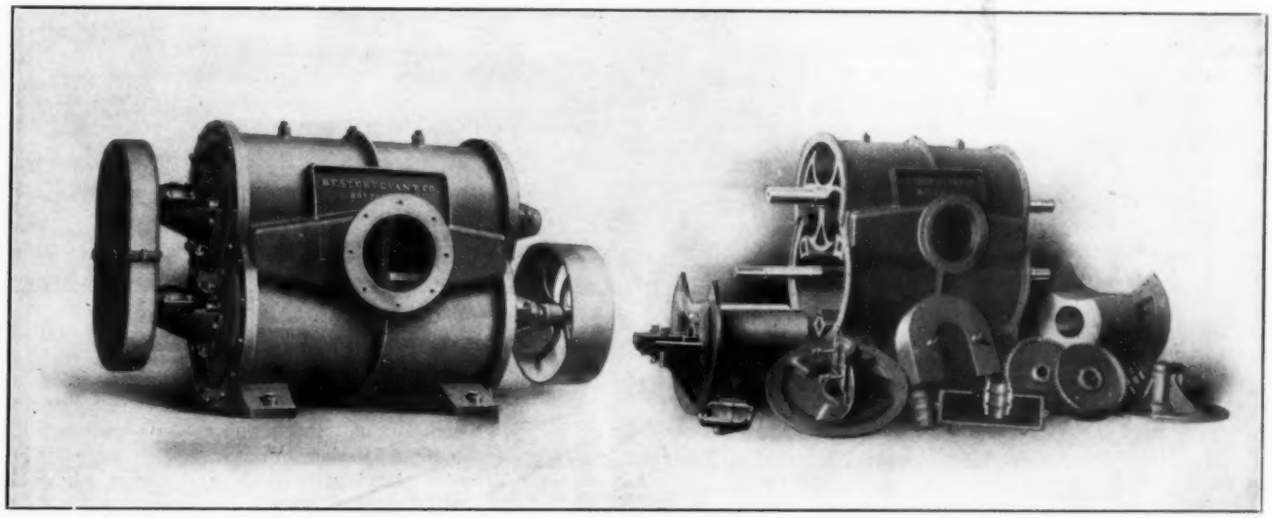


FIG. 6. THE STURTEVANT HIGH PRESSURE BLOWER, ASSEMBLED.

FIG. 7. THE STURTEVANT HIGH PRESSURE BLOWER, DISASSEMBLED.

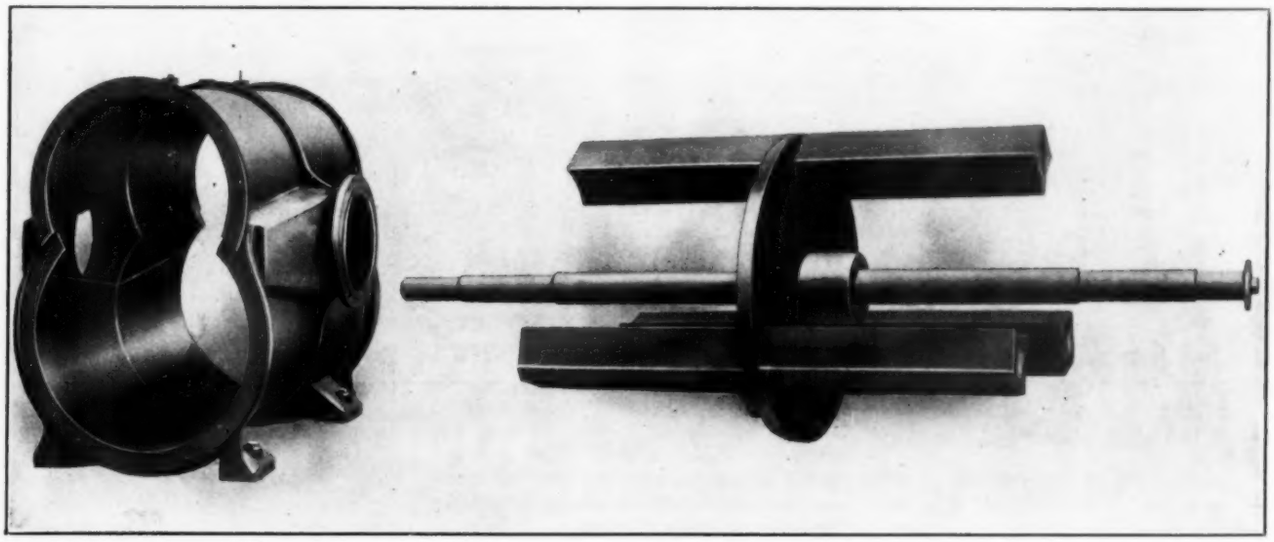


FIG. 8. SHELL OR CASING FOR BLOWER.

FIG. 9. ROTATING "IMPELLER."

governor. For transferring gases and air at high pressure, stuffing boxes are provided for the shafts, and a drain in the bottom removes tar and other distilled liquids.

OPERATION.

Air at atmospheric pressure entering the blower at the intake is successively imprisoned in the three pockets formed by the three blades of the revolving impeller, and discharged at any desired pressure up to ten pounds per square inch. The volume of free air delivered varies directly with the number of revolutions; the pressure varies with the resistance met in the delivery pipe.

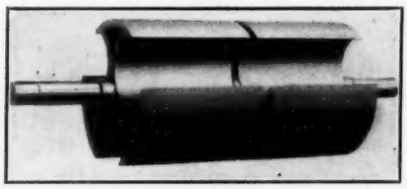


FIG. 10. ROTATING "IDLER."

The principle upon which the blower operates is clearly shown by the diagrams, Figs. 1, 2, 3 and 4, which are sectional views of the rotors and casing. In the explanation it is assumed that the blower is running at a speed to produce average pressure, and that this pressure exists in the discharge outlet.

While the rotating members were in the positions shown in Fig. 1, air entered freely and completely filled the chambers X and D, while pockets E and Z were discharging air to the delivery pipe. From the previous movement of the rotors, the pressure in Y, filled with air carried over by the revolving idler, had been increased slightly by air flowing through the leakage passage N as will be explained later. The space between blades A and C, just above the concave portion of the core, was practically filled by the wing of the idler, and consequently while in this position it took no part in the action.

While revolving from the position of Fig. 1 to that shown in Fig. 2, the air in pocket D has been carried along and the communication between chamber D and the inlet has been cut off. Space Z is filled with compressed air which further movement will carry toward the suction end where it will flow back to the inlet and in escaping cause noise. But this noise and loss is prevented by the leakage chamber O which allows the pressure to be transmitted to the air in space Y thereby increasing its density just before it is discharged.

Continued rotation carries the rotors to the position shown in Fig. 3; atmospheric air is now entering pocket F, the air in D is being carried around between the blades A and B in the annular space, and E is discharging. Above the impeller the remaining pressure in Z is being transmitted to the air in X by means of the leakage passage N provided for the purpose, thereby making its pressure a little greater than atmospheric. The air in space Y under slight pressure from previous leakage is imprisoned, and being carried around by the idler.

When the fourth position is reached, pocket F will be filling, the pressure in chamber Z will have been reduced to atmospheric by leakage, space Y will discharge and a little compressed air from the delivery pipe will flow back through leakage passage M and increase the pressure in D which will result in a quieter discharge and a little compressed air from the B into the discharge passage.

The purpose and advantage of the leakage chambers is now apparent; they make make it possible to recover the pressure tending to escape from the impeller pockets and by making the increase in pressure gradually cause the blower to run with less noise. Leakage passage L has little effect when the blower runs in the direction shown here; it is made to allow the blower to be reversible.

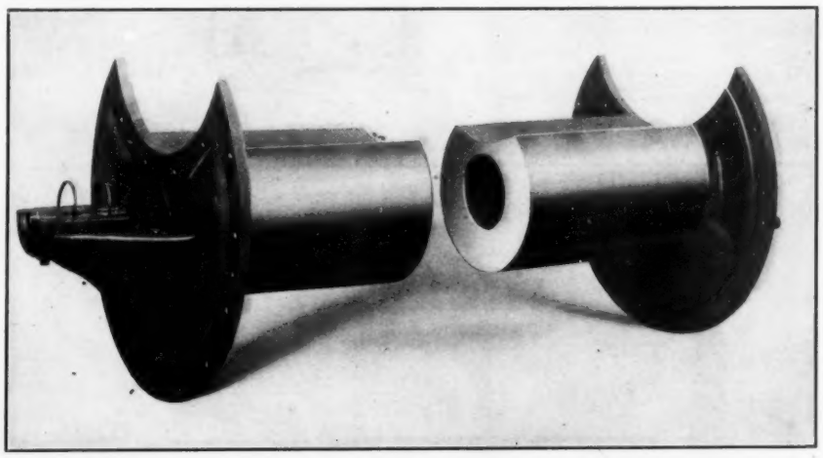


FIG. 11. FIXED "CENTRAL CORE."

It will be noticed that the impeller carries three blades, set at equal distances around the periphery, thus causing three admissions of air at each revolution. Upon leaving the position shown in Fig. 4 the rotors quickly reach a position in which the conditions are exactly the same as those shown in the first figure, the operation continuing as explained.

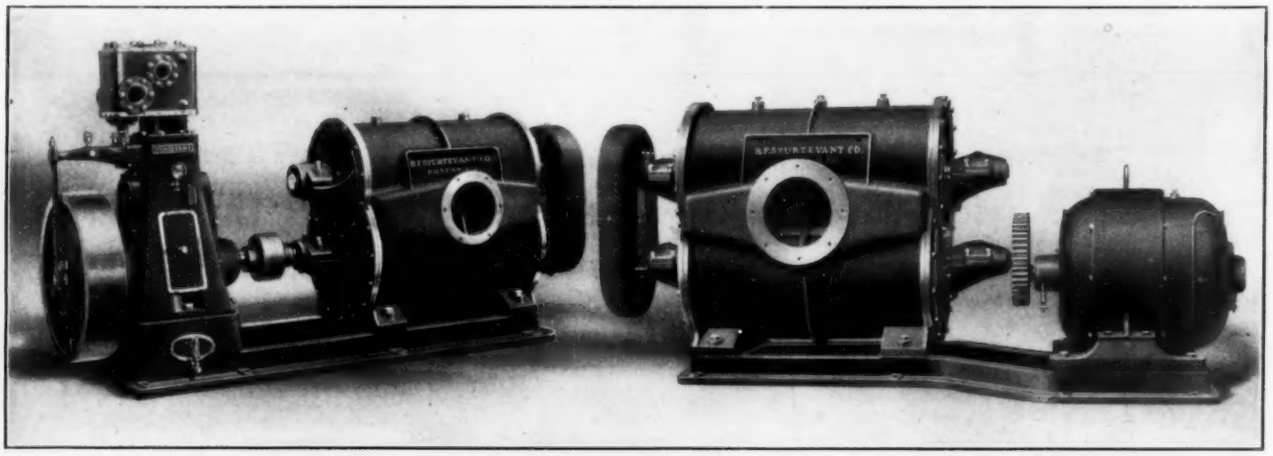


FIG. 12. DIRECT COUPLED ENGINE-DRIVEN BLOWER.

FIG. 13. GEARED MOTOR-DRIVEN BLOWER.

City Ownership in Berlin.

A recent press despatch says:

At a conference of the Berlin municipal authorities with the municipal officers of eight suburban towns, it was resolved to take the initiatory steps to acquire the Berlin Street Railway Company, which has practically the monopoly of the street railroads of Berlin and its suburbs, and to operate roads upon the joint account of the nine municipalities. The company has a capital of $25,000,000.

Some Special Forms of Inside and Outside Gears.

BY ROBERT SIBLEY.*

A recent discussion by some of the engineering students in the University of Montana, arising over one of the link motions used in the modern automobile, resulted in devising the following notes and formulas in regard to inside and outside gears with movable centers.

The particular problem under discussion was as follows: A spur gear of 12 teeth with a movable center meshed into an inside gear of 60 teeth with fixed center, as shown in Fig. 1; how many times would the movable shaft rotate when the teeth of the small gear meshed with the 60 teeth on the big fixed gear? Furthermore, suppose the little gear wheel to roll on the outside of the big wheel, as shown in Fig. 2; how many times would its shaft rotate when the teeth of the small gear had meshed with every one of the teeth of the big spur gear?

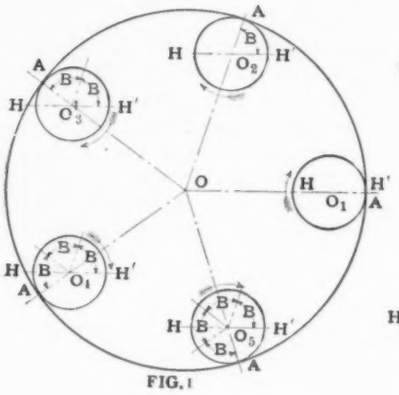


FIG. 1

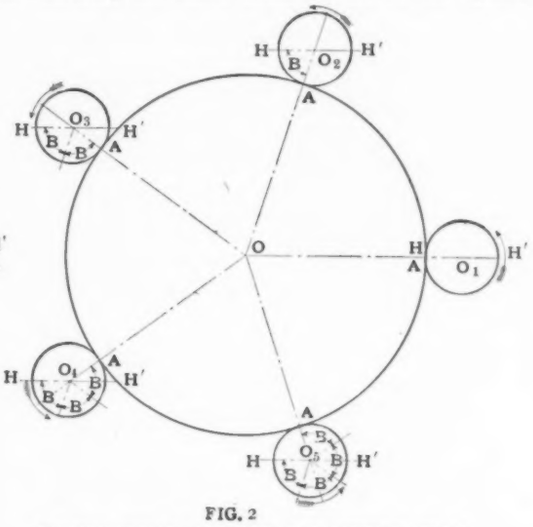


FIG. 2

SPECIAL FORMS OF INSIDE AND OUTSIDE GEARS.

At first sight one would say, since 12 goes into 60 exactly 5 times, of course the little shaft must rotate 5 times whether rolling inside or outside of the big wheel. Such is not the case, however, as will be shown. Should both axles or shafts be permanently fixed, then the usual law of gears would certainly apply, and we would have 5 revolutions whether the gear be placed inside or outside, but the movable shaft in following the big wheel loses exactly one rotation per revolution on the inside and gains exactly one revolution when rolling on the outside.

Let the wheel with center O_1, Fig. 1, engage its 12 teeth on the inner circumference of wheel with center O. If O_1 were stationary, this would require one complete revolution of the shaft, or it would turn through 2π radians. However, O_1 all this time, due to its own motion, has been rotating in an opposite direction about O. Since its amount of rotation is directly proportional to the number of teeth on the two gears, we have the angle through which O_1 has rotated to be equal to $\frac{N_1}{N}$ of 2π radians, where N' is number of teeth on the small gear, and N the number on the fixed gear. Hence the net turn of axle O_1 in radians, every time its 12 teeth mesh over a corresponding number in the big gear is $(1-\frac{N}{N})$ of 2π radians. In covering the entire circumference of the big wheel, the total number of times the 12 teeth will mesh with the big gear is $\frac{N}{N_1}$. Therefore, net turns of axle =

$$\frac{N}{N_1}\left(1-\frac{N_1}{N}\right)=\frac{N-N_1}{N_1}$$

On the other hand, let us consider for a moment the movement when the wheel rolls on the outside of the big gear, Fig. 2. Here the movement of the outside center O_1, with respect to the big center O, adds its effect instead of subtracting; hence, by a similar derivation, the total number of turns of shaft O_1 is

$$\frac{N}{N_1}\left(1+\frac{N_1}{N}\right)=\frac{N+N_1}{N_1}$$

By substitution in the formula for the given data, we find that the rolling gear actually rotates but four times in covering the 60 teeth on the big gear when rolling inside, while, when rolling on the outside, it actually rotates six times.

Aside from the above mathematical demonstration, the law of the rolling in this case is easily seen from the graphical demonstration in Figs. 1 and 2. Take, for example, Fig. 1. When the entire circumference of O_1 has rolled on the circumference of the inner circle, point A will be located as shown at O_2. As the wheel is rotating in a clockwise direction, we see that the shaft at O_2 lacks the angle B from making a complete revolution. By following this around to O_3, O_4, O_5 in turn, we see that each lags behind the other by this same angle making in all $5B$ when the wheel arrives back again at O_1; hence a complete revolution has been lost.

Even if the little wheel is not contained an integral number of times, a whole revolution will be lost in one case and gained in the other, since angle $A\,O\,H'$ in any particular case is always equal to angle $A\,O_2\,H'$, etc., and when angle $A\,O\,H'$ becomes 2π radians, or one complete turn, the little wheel has arrived again at its starting point and lost or gained a complete revolution if it be inside or outside gearing, respectively.

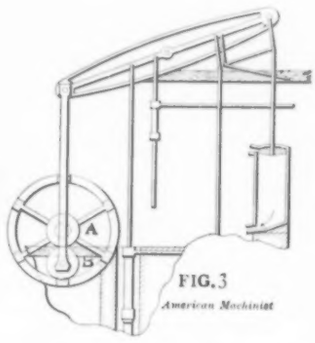


FIG. 3

American Machinist

This particular form of gearing was used by James Watt in his first steam-engine crank connection. This is shown diagrammatically in Fig. 3. In those days it was practically impossible to weld iron in a shape of sufficient strength and size to meet the immense turning moment experienced at the crank of an engine.† Sixty teeth were used on a movable crankshaft. These meshed with sixty teeth on the crosshead gear fixed to the connecting arm.

By applying our previous formula for outside gearing with movable centers, we may now easily see why it was that the famous inventor secured the remarkable result of two revolutions of the crankshaft for every revolution of the connecting-rod.

*Professor Mechanical Engineering, University of Montana.

†[We have always understood that Watt devised this "sun and planet gear" because of an existing patent which prevented his using the crank.—Ed.]

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The British Engineering Standards Committee.

The movement toward standardization in manufacturing originated in England, the Whitworth screw thread being, to the best of our knowledge, the first important standard seriously proposed, as it is the one which has obtained the widest acceptance; for it is not only far better established in England than is the Sellers thread in this country, but it has also been widely accepted in continental Europe. Until recently, however, the movement toward standardization made much greater progress in this country than in England—the whole system of duplicate manufacturing, in a broad sense, being probably the most creditable single contribution of American mechanics to the art of machine construction.

The importance of standardization has, however, impressed itself on British engineers and has led to a movement which in its scope and thoroughness is entirely characteristic of our next of kin. We refer, of course, to the work of the Engineering Standards Committee, to which we have made several references in the past, but of which a recent report of progress gives an opportunity to present a comprehensive account of this remarkably meritorious work.

The committee originated in a motion of Sir John Wolfe Barry before the Council of the Institution of Civil Engineers in 1901, the result being the immediate appointing of a committee of six by that body. The committee soon recommended to the institution that other engineering societies be invited to co-operate, the early result being the enlargement of the committee by members from the Institution of Mechanical Engineers, the Institution of Naval Architects, the Iron and Steel Institute, and the Institution of Electrical Engineers. At a later date the importance of the work was laid before the then government and the result was a grant of £3,000 for the first year, and of smaller sums for subsequent years, these sums being supplemented by subscriptions from manufacturers and railway companies. The main committee now consists of nineteen members, the work being divided among thirty-three sectional and sub-committees, which are largely composed of members of societies that are not represented on the main committee, such as the Institute of Gas Engineers, the Association of Water Works Engineers, the Institution of Heating and Ventilating Engineers, etc., the main committee calling to its aid in the formation of the sub-committees representatives of the interests directly interested in the work of a given sub-committee.

The work of these committees has been extremely fruitful, twenty-four reports having been issued at this time, covering rolled sections, locomotives, pipe flanges, cement, tests of materials for ship and bridge building, telegraph material, electrical machinery, screw threads, etc., and in addition to the reports standard templets have been prepared and placed on sale for railway and tramway rails and pipe flanges. The reports are not published for gratuitous distribution, but are sold at prices varying from one to twenty-one shillings per copy, and the number sold, ranging up to two and three thousand for single reports, indicates the serious interest manifested by manufacturers.

No such comprehensive, far-sighted and public-spirited action was ever before undertaken by any body of engineers, and if any additional evidence on that point is needed, it might go far toward removing what remains of the impression that England's day as a great manufacturing nation is drawing to a close.

New Publications.

"Modern Machine Shop Construction, Equipment and Management." By Oscar E. Perrigo, 343 7½-inch pages, with 208 illustrations. The Norman W. Henley Publishing Company, New York. Price $5.00.

The object of this book may be gathered from the statement on the title page that it is "a work for the everyday use of the architects who design, the manufacturers who build, the engineers who plan and equip, the superintendents who organize and direct, and for the information of every stockholder, director, officer, accountant, clerk, superintendent, foreman and workman of the modern machine shop and manufacturing plant of industrial America." Although thus handicapped by its title page, the book contains a good deal of valuable information. We have little faith in the value of general plans of an ideal works designed to suit assumed conditions and an assumed plot of ground nor in floor plans showing an assumed equipment of the tools which fit their places like the squares of a checker board. It is too easy to thus make them fit when no particular kind or volume of product is to be provided for. Nevertheless, many details of construction, for instance, the slow burning system, floors, roofs, windows, etc., will be found useful. The book is divided into three parts: Machine Shop Construction, Machine Shop Equipment and Machine Shop Management, the last relating chiefly to accounting and system.

A friend of ours wishes to obtain, in lots of considerable size, flat rings, made of 3/16x¾ inch machine steel, bent into a circle edgewise, with an inside diameter of 19¼ inches, and an outside diameter of 20¾ inches and welded, either electrically or otherwise. The rings to be within 1/16 inch of true and flat. Does anybody know who can make such rings?

New Tools and Machine Shop Appliances.

SCREW-SLOTTING ATTACHMENT FOR BENCH LATHE.

The half-tone illustrates a screw-slotting device to be clamped to the bench lathe. As will be noted, the holder for the work, or the body which receives the spring collet, is square. Therefore, in addition to its use in screw slotting, it

SCREW-SLOTTING ATTACHMENT FOR BENCH LATHE.

may be used as a squaring fixture to finish the end of a piece for a wrench or key; and as it admits the same chuck as the lathe spindle, the workman can use the one chuck in both places and also can do many jobs in a small miller with the device. The squared portion of the holder simply rests in the V-support and the two nurled lock-nuts form a stop when feeding the work to the cutter. The nurled piece below the V-block adjusts the work to the proper height. The base of the fixture has a T-slot in the bottom and is clamped to the lathe bed by the slide-rest bolt. This tool is manufactured by Hardinge Bros., Chicago, Ill.

A RADIAL DRILLER.

The illustration shows a radial driller designed to meet the conditions imposed by the use of drills of high speed steel. The feed mechanism in the head provides four changes from .0069 to .0203 inch per turn.

The feeds can be automatically tripped at any position of the spindle by an adjustable trip dog acting on the worm clutch. This trip acts automatically at the full depth of the spindle, preventing breakage.

The spindle has eight changes of speed ranging from 37 to 295 revolutions per minute, all available without stopping the machine.

The arm is so designed that the lower line is parallel with the base permitting work to be operated upon close to the column without the necessity of an extreme reach of the spindle. The tapping mechanism is between the back gears and the speed box, permitting heavy tapping to be done.

The box table has a top surface of 16 by 26 inches and side surfaces of 6 by 26 inches. With this tool no wrenches are required. It is made in three sizes, with 2½, 3 and 3½ ft. arms, by the American Tool Works Co., Cincinnati, Ohio.

SUB-PRESS.

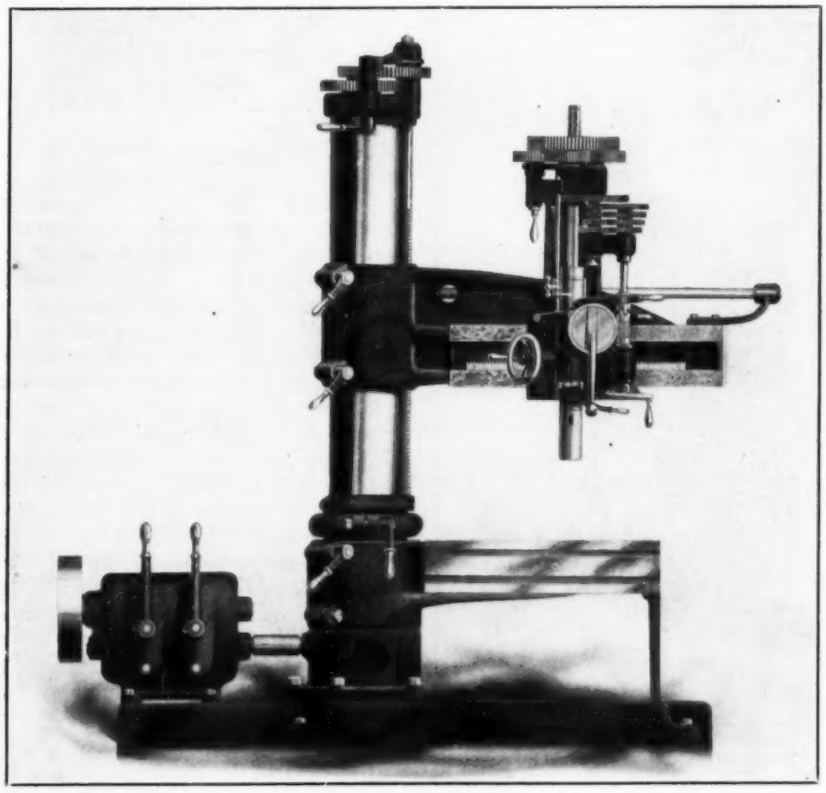
This sub-press is constructed with open front so that the material can be passed in straight or at almost any angle, and the throat is deep enough to admit stock of considerable width where desirable. The

SUB-PRESS.

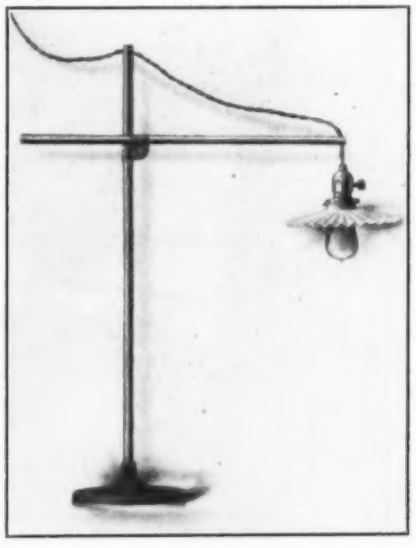
plunger works in a babbitt-metal guide and provision is made for compensating for wear. The press is constructed for ½-inch or 1-inch stroke as desired. The maker is the Meyrowitz Manufacturing Company, Thirty-first street and First avenue, New York City.

A PORTABLE ELECTRIC LAMP STAND.

This portable electric lamp-stand is designed to meet the requirements in shop and factory for a simple and cheap adjustable lamp support that can be used on



A RADIAL DRILLER.



A PORTABLE LAMP STAND.

the bench, floor, surface table, etc. With this device the light can be adjusted in an instant without any trouble, there being no screws to loosen or tighten. The cord can also be instantly detached whenever it is necessary to use the light independent of the stand. The base is gray iron, and the bars of hardwood, varnished, which combines lightness with the quality of being a non-conductor. Slots are cut in the ends, which pinch the cord. The cross bar can slide either way. The joint is a steel stamping; it is universal, and clamps both bars with spring tension. It is made by the Gem Manufacturing Co., 467 Eleventh avenue, Milwaukee, Wisconsin.

A BACK-GEARED CRANK SHAPER.

The illustration shows a 28-inch back geared crank shaper designed for use with tools of high speed steel. The ram has eight changes of speed ranging from 15 to 181.5 feet per minute, with the machine running full stroke. The stroke is adjustable while the machine is in motion. The ratio of the back gearing is 1 to 29.4.

The head swivels 50 degrees on either side of vertical. The down feed reads to .001, and has a traverse of 9 inches.

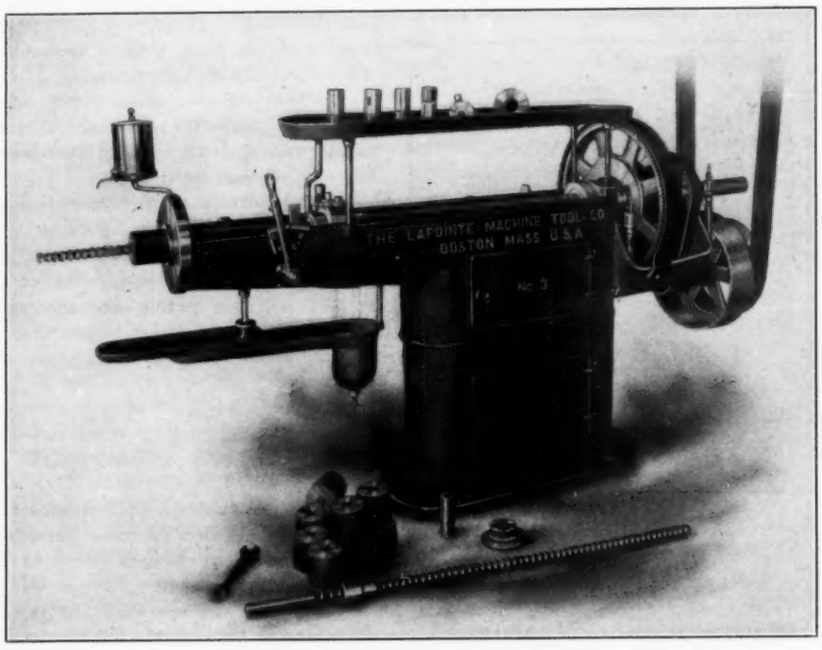
The elevating screw is telescopic and fitted with a ball thrust bearing. The vertical travel of the table is 13¼ inches. The cross feed is variable, having a range from .0114 to .250, and has a traverse of 31 inches.

An opening in the column permits shafts up to 3½ inches diameter, to be passed through it for keyseating, etc.

This line of shapers from 16 to 28 inches stroke—inclusive—is built by the American Tool Works Company, Cincinnati, Ohio.

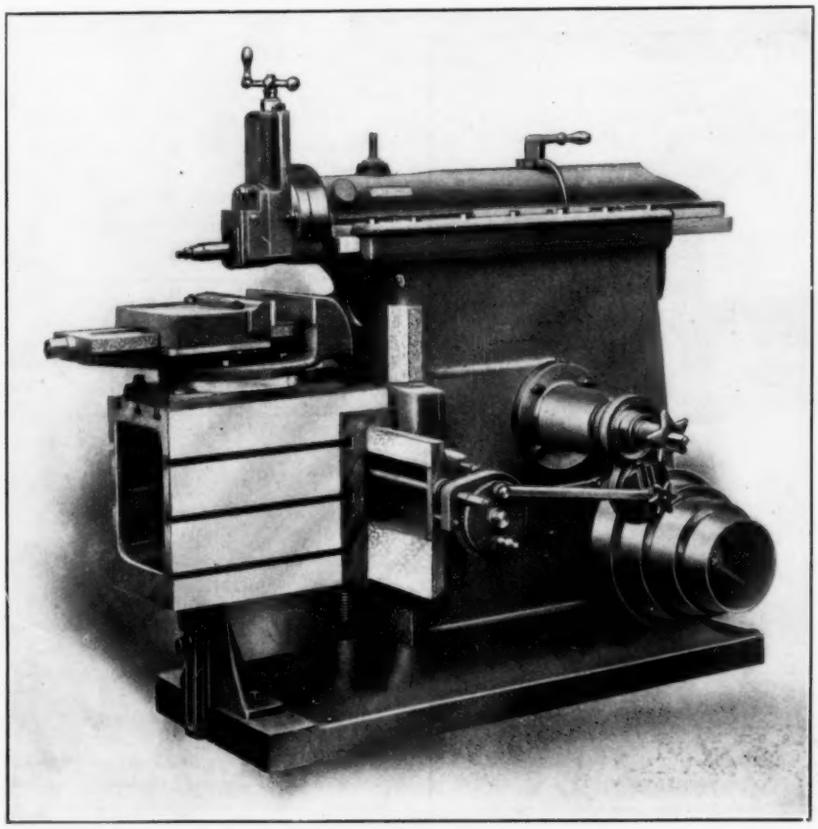
KEYSEAT BROACHING MACHINE.

This machine is designed for the broaching of keyways, straight, tapered, or dovetail also for forming oil channels and broaching square or hexagon holes from drilled or cored openings. The cutter is actuated by a screw which is operated by a rotating composition nut. The drive is by a pulley located at the rear which operates a driving pinion on a shaft under the large gear. The head, which is attached to the screw, slides on the ways when the machine is in operation and is fitted with



KEYSEAT BROACHING MACHINE.

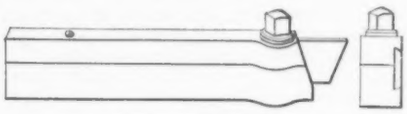
an auxiliary head which holds the cutter-bar or broach-holder and can be adjusted so as to be in alinement with the work. The machine has an automatic stop and is provided with a friction quick-return which is controlled by the vertical handle and operated by a belt from the driving shaft. The work to be splined or broached requires no clamping, the parts being merely slipped on to the sleeve on the face plate, and the carrier bushing being slotted at one side to form the guide for the tool and allow the latter to come in contact with the work. In small work such as gear blanks, etc., one to one and one half inches in length, two or three can be done in one operation, thereby reducing the time for each part. The machine in the illustration was designed especially for broaching square holes for automobile parts such as universal joints, hubs, gears, etc., as well as for keyseating. A 1⅛-inch square broach is shown half way through the work which is of machine steel two and three quarter inches in length. The hole is broached square from the drilled hole in one operation, the time in this case being one and a half minutes. The pan above the machine is to hold such parts as are used in the operation. The four draw bushings are for holdings splining cutter-bars; these are threaded standard. The machine is built by Lapointe Machine Tool Company, Boston, Mass.



A BACK-GEARED CRANK SHAPER.

CUTTING OFF TOOL.

This holder is made in two sections and provided with two screws for clamping the sections together for holding the cutter fast while grinding. The pressure of the tool-post screw not only re-



CUTTING-OFF TOOL.

tains the holder in position, but also holds the cutter with additional firmness. The holder is drop forged of open hearth steel, finished in a suitable manner, case-hardened and provided with a drop-forged wrench. The cutters are of high-grade tool steel. The Billings & Spencer Company, Hartford, Conn., is the maker.

Electric Driving of Machine Tools.

While the losses of power in transmission by shafting and belting are very generally represented by 50 per cent. of the output at the engine, the corresponding losses in the case of electric transmission from engine to tool are rarely more than 25 per cent. But it must be borne in mind that losses for mechanical transmission are constant and that those for electric transmission vary with the energy consumed. Hence the power required for electrically-driven tools is usually much less than half that necessary for belt-driven tools. In addition to the saving of power, electric driving possesses the further advantage, that a greater output per machine is obtainable, owing to the flexibility of the method, and, further, its cleanliness and the non- obstructher, its cleanliness and the non-obstruc-features of much importance in many engineering workshops.—*Engineering Review.*

The comparative merit of escalators and elevators is not a matter of theory alone, but is disclosed by practical results; thus, in Macy's department store in New York a careful count was kept during the month of December, 1905, up to and including Christmas Eve, and the average showed that the Otis escalator took more people away from the first floor than all the elevators in the building, and it has always carried more passengers than the eight elevators which are in its close proximity. Besides the great saving of space, the escalator possesses the advantage that it marshalls the ascending and decending crowds, separating them and avoiding the congestion and confusion which occur in the neighborhood of elevators or stairways.

Petty bickerings do not contribute much more to the making of manhood than fleas do toward the making of the dog,

The Open Shop, the Boycott and a Boomerang.

The printers on this publication went on strike January 1 for an eight-hour day at the nine-hour pay and the perpetuation of the closed shop.

We issued to these men the circular printed on the following pages—but they all went out, are out now and, so far as we are concerned, always will be out.

We had no difficulty in finding men to do our work, as we pay the highest wages, give our men the best treatment and have the lightest and cleanest place in New York in which to work.

We have no objections to unions or union men except in so far as they assume control over the rights, life, liberty and happiness of others.

Because we stood out against the closed shop, the Typographical Union has issued a black-list in which our name appears. This list is sent to union offices—not to the owner, but to the "chairman of the chapel," who works for the union—to prevent these union offices from doing any of our work.

Our publications have been placed on the "unfair" list and union men are asked to boycott them.

Now that the fight is on it seems well for us to put ourselves on record and to let our readers and advertisers know just exactly where to find us on this all-important question.

In the first place, be it known that our papers are purely technical. They discuss only those subjects relating to the business they represent, and avoid labor disputes and labor news. Each of our three papers is published to disseminate information about the work in hand—the real making of machinery, generation of power, or the extraction and milling of ores.

Some papers in our lines rant against the encroachments of labor in the field they represent, and thus cater to the employer of labor—yet were among the first to lie down and let the printers' union walk all over them in their own fight.

Our papers have been fair to employee and employer, because we have not taken sides. We do not propose to take sides now in a dispute about wages or hours or any of the hundred other differences of opinion as to the right and wrong between men who hire and men who sell labor. These disputes are largely based on local conditions.

On the question of the OPEN SHOP the HILL PUBLISHING COMPANY and the three papers printed by it, the AMERICAN MACHINIST, POWER and THE ENGINERING AND MINING JOURNAL, stand four-square to the world for the OPEN SHOP; not alone in our own plant, but in every institution, great and small, reached by or through these papers.

This we do now and shall do, not for the benefit alone of the employer of labor, but in the true interest of every man who works for his daily bread.

The closing of the workshops of this country in any trade is a menace to personal liberty greater than any ever attempted or dreamed of by any other monopoly-hunting trust on earth.

We claim the right of men to organize for any legitimate purpose, therefore we do not oppose great aggregations of capital or great organizations of workmen—except when either of them attempt to monopolize and control something, when such monopoly tends to rob some or all of us of something that is our own. We are opposed to monopoly in any form.

Free, open competition is demanded for everybody. We believe that the American people are sick of shouldering the useless expense, annoyance and trouble caused by strikes and lock-outs where the issue is "the recognition of the union" or the closed-shop question.

We believe we will serve the best interests of the good, capable workmen of this country if we can materially aid in bringing about the universal adoption of the open-shop principle—and we propose to do it.

The right of every man to work when and where he pleases, for the best wages he can secure, should be undeniable. Yet the closed-shop unions do deny this right and abuse, vilify and assault the man who works where they refuse to work.

The right of every shop-owner to hire whom he can, on the best terms he can, should also be undeniable, yet these unions do not hesitate to conspire to drive away his employees, to stop his works and boycott his product to ruin his business.

Now when the American people are convinced—and they are long suffering—that their rights and liberties are attacked, they deal swiftly and surely with the usurper. Our liberties are attacked, and the people are demanding relief *now.*

This is no time for any individual or any publication to straddle and wabble and dodge the issue.

Here are the two sides:

The open shop, free opportunity, a chance for young men to learn trades, liberty, and the development of all our national industries, or

Monopoly, intrigue, bossism, restriction of output and apprentices, coercion, and the blight that comes to manufacturing, trade and commerce when in the hands of irresponsible autocrats whose only law is rule or ruin.

For sooner or later every close-communion union gets into the hands of a clique of rampant talkers—the best members do not take part, they blindly obey.

The union membership is only a small

percentage of the workmen of this country, yet they assume to make laws of their own that debar a majority of American workmen from free opportunities.

Now this minority of workmen, with their talking officership, never hesitate to take the offensive and to tell what they will do to and about all who disagree with them, and it has become a habit for people, especially employers, to fear them and surrender before a fight.

When they have been met fairly, face to face, for an open fight, where they were in the wrong they have always been whipped.

One remedy then, is to face the question and fight for freedom.

The boycott and the black-list are favorite weapons of the star-chamber clique of the unions, as the stiletto and a dark night are the favorite weapons of the Corsican bandit.

But the "unfair list" is becoming so large and the names there include so many of the foremost concerns in the land, that it has become more a roll of honor than anything else.

Our papers are boycotted. Well and good! We hope for the patronage of only such readers and advertisers as believe in individual liberty; who realize that the closed shop has already led to the partially censored press, and may lead to the closed mouth.

We have an abiding faith that the free and fair men of the industries we represent are in the majority.

We hope to deserve their continued patronage and have already arranged to get along without the aid of those who are opposed to the liberties of *others,* as well as themselves.

Go ahead with the boycott! We have a notion it's an old-fashioned smooth-bore anyway, and have some doubts if it's really loaded with a "service charge" meant to and able to do damage.

When the people of this free country have to organize citizens' alliances and anti-boycott associations to protect themselves from the annoyances and impositions and expenses of the attacks of a comparatively few union men, to close shops and mines to men who do not care to join them, it is high time for the people who love and respect our Ship of State to line up and arm to repel boarders.

We appeal to the honest and efficient workmen of this country to come out for the open shop.

Keep up your union if you have one, attend its meetings, talk and *vote,* and do not believe the professional agitator who declares that all employers are rapacious and that the closed shop is the only insurance of union stability.

Employees are like other men—good, bad and indifferent, but mostly fair.

Other unions, like the Brotherhood of Locomotive Engineers and the Brotherhood of Locomotive Firemen, are open-shop unions; they work with anybody the company hires and have each done more for their membership than any closed-shop unions on earth.

The National Association of Stationary Engineers is purely educational and devotes all its energies to making its members better engineers, which will in time, if it has not already, put its men in the "preferred list" of all fair-minded employers—men who want to hire efficiency will soon find where it is made.

We have no sympathy for the union baiter who proposes to destroy the unions. Workmen have the same rights and the same incentives to form unions as the employers have to form associations in their trade.

On the other hand, we have no use for the rule-or-ruin policy of those unions that strike for the closed shop and a monopoly of employment in any trade. We are not against the unions, but the unlawful acts of unions.

All the intelligent mechanic of this country needs is a free opportunity to work, and, if he be ambitious, to advance himself—to become a foreman, a superintendent or an owner.

The closed union tends to make a workman always a workman.

These three publications are issued for and in the interest of ambitious men—men responsible for results somewhere, men who "do things."

We do not believe that any considerable number of them will throw away a valuable tool of their trade because it is partly made by men receiving higher wages than the unions ask, and where the proprietor and his representatives run the plant without volunteered assistance from the outside.

We are not afraid of the strike, or the pickets, or the black-list, or the boycott. We believe that the boycott is a boomerang nine times out of ten—go ahead with it!

We believe in the open shop for America, and shall do our level best to secure it in every industry.

If the unions can punish us for taking this position, we will take "what's coming to us" with as good grace as may be, consoling ourselves that we stood for the right as it is given us to see the right.

JOHN A. HILL,
President.

New York, January 30, 1906.

Copy of Letter Addressed to Our Compositors, December 21, 1905.

As is well known to all of you, the International Typographical Union has ordered a strike for January 1st, 1906, to inaugurate the eight-hour day, with nine hours' pay, and the perpetuation of the closed-shop rule.

Now, I have a few words to say to you, and as I do not wish to be misquoted or misunderstood, I have written them down, and any one of you can have a copy, if he so desires.

Those of you who know me, know that I am not myself opposed to labor unions. I am this moment still an honorary member of the best one in America—the Brotherhood of Locomotive Engineers—the great open-shop union.

This Company, and the whole fraternity of employing printers, could deal better with you organized than as individuals. You have rights as union men; but you must not forget that others have rights also—and this, I believe, your labor leaders have forgotten.

Those of you who know me, also know that I am inclined to pay more than the scale to good men, or grant them other privileges that amount to the same thing.

For seven years you had good wages—many of you over the scale—and were paid for every holiday, and did not work; you were paid for every Saturday afternoon, and did not work; you were paid when sick; and you were given a little vacation each summer and other privileges and emoluments which some of you at least will remember.

This was beautiful as long as it did not interfere with your union creed; but when I wanted to put a proof-reader into the place, who had been a faithful and efficient man in the office, and understood the technical matter handled by the new paper, the union stepped in and kept him out. Then, and not till then, did I commence playing the game according to the union rules. You lost $2,000 per year worth of free time to keep one man out of the shop. If you do not believe this, ask Mr. Gross, your Superintendent.

You and I, and all the rest, may have honest convictions, we may wrangle, and debate, and compromise on a question of hours or pay, but never on the question of the closed shop.

This imported, closed shop, that prevents young men from learning the trade; that restricts output; that keeps improved machinery products down; that forbids the owner of the plant from having his own foreman, or any other representative in the workroom—is in itself wrong. It is against the liberty of men. It is slavery. For me, it is the violation of a religious principle.

Too much power is bad for either capital or labor. But capital must obviously have some control of its property.

Your minds are probably made up on that question, and so is mine.

I want to say to those compositors who will walk out January 1st—that this composing room will open January 2d as a nine-hour, open shop. If you do not wish to man it, well and good; someone else will.

None of you is foolish enough to believe that you, or any other set of men, can, or will, do as much work in eight hours as you do in nine. If this *is* true, then are you doing the fair thing now?

The cutting down of the output of this plant one-ninth means more machinery or wasteful overtime.

Your union figures that the increase of cost will be 15 per cent. The Typothetae figures 23 per cent. At your own figures, this means a yearly increase to this Company alone of $11,900 for the same work you are doing now, and to the Typothetae of New York $594,000 per year. The printing business cannot stand it.

The compositors of New York have had an increase of pay since we went into business seven years ago of more than 30 per cent. Five times have they asked for concessions—and received them.

Prior to 1898, your pay was $3 per day—30 cents per hour. January 1st, 1898, the nine-and-a-half-hour day, ten hours' pay, went into effect, making your pay equal to 31½ cents per hour. November 2d, 1899, the nine-hour day was established, making your pay equal to 33 1-3 cents per hour. January 1st, 1902, your pay was raised to $3.16 2-3 per day, making it equal to 35 1-5 cents per hour.

October 1st, 1902, the pay was again raised to $3.25 per day, making it equal to 36 cents per hour. Again on January 1st, 1905, the pay was raised to $3.50 per day, making it equal to 39 cents per hour.

Now, if your demands were to be met, the rate would be 44 cents per hour—a total raise of nearly 50 per cent.

You are going too fast.

Hereafter we shall pay the union scale, or more, for good men—union or non-union.

Nine hours is a very comfortable working time for clean, light, indoor work, where the owner furnishes all the tools, and has many thousands of dollars tied up in a plant. There is some excuse for the brick-mason's eight hours. He works at very dirty, heavy work, in all kinds of weather, making only an average of five or six months a year, and he furnishes his own tools. His employer has no expensive machinery idle when he quits early, and can always help himself by putting on more hands, and there is room for them.

The opportunity for individual initiative, the possibility for any workman to become a master, has made this country what it is in manufacturing and all other industries.

The closed shop means the changing of all this to the foreign standard, where a workman is always a workman, where ambition is still-born and hope is dead.

The open shop means the freedom of every man to do what he thinks best for himself, provided he does not encroach upon the liberty of others.

I am content to leave the door of opportunity wide open to all with ambition enough to enter. I oppose any attempt to close that door, to strangle ambition, or to prevent an abler man than I from earning more.

The American idea is good enough for me.

So far as I can learn, no single stockholder of this Company ever inherited a dollar. Each and every one of them commenced at the bottom and dug himself out.

This is not a corporation of greed, but a lot of men like yourselves, who have worked hard for what they have, and want to keep their own.

Their years of experience with this Company as workmen, as managers, as owners, have taught them that this closed shop is dangerous; that the eight-hour day is inopportune; that the union cannot run this plant.

Here are a few things I wish you would think about:

First—No printer ever succeeded in establishing himself in business who worked eight hours a day.

Second—There are very few, if any, composing rooms in this city that pay, even at the present scale—they are necessary evils that printers would be glad to get rid of.

Third—The price of composition is governed by out-of-town printers.

Fourth—Remember that this Company is willing to pay more than the scale—to pay men for what they do, not for what they belong to.

Fifth—That the closed-shop union tends to grade the workmen *down*, not *up;* it puts you all on the level with the average dub, and prevents you from earning what you deserve.

Sixth—That while we want only an open shop, with no outside control of what a man does, or what he *earns* above the scale, if you leave you oblige us to establish a non-union composing room until the war is over.

I shall be sorry to see a man go away—especially those who have been with us from the start. I do not believe that you can get better jobs or a more appreciative "old man." But this "old man" cannot stand everything. The savings of a life of hard work are in this concern, and all the fun he can get out of it is to run it his own way, with due regard for the rights of others. He always has worked more than eight hours a day, and always expects to.

If the officers of a labor union run this concern, someone else will own it—I won't.

Hereafter the foreman works for the owners, and not for the union.

I believe I know how most of you feel about working during a strike, and shall not ask you to do so. However, if any of you do want to stay, regardless of the union, I will make a three years' contract with you before January 1st; but not after you have once gone out.

And those who stay can keep on staying, union or no union, eight hours or nine, and I will put that in the contract.

In employing printers hereafter, one thing we shall insist on, and one only—that he be a good workman. We will not ask his pedigree nor demand to know whether he be married or single, Methodist or Catholic, Democrat or Republican, union or non-union.

We want men who want to work here, and who are willing to give an honest day's work for an honest day's pay.

We want men who have common sense enough to know when they are being treated fair or ill, without being told.

Now the whole thing simmers down to about this:

You say to us—Shut down this plant another hour per day, pay the same wages that you do now, and place the conduct of the shop in the hands of our union and walking delegate, or we strike.

We say to you—We insist on our right to run our own concern nine hours per day, run an open shop, and employ whom we please. If that is the issue, go ahead—we will fight.

HILL PUBLISHING COMPANY,
JOHN A. HILL, President.

Thermo-Electric Pyrometers.

The January reunion of the American Society of Mechanical Engineers, held at the society house the evening of January 30, was highly entertained by and interested in a paper by Professor W. H. Bristol on "A Low Resistance Thermo-Electric Pyrometer and Compensator."

Professor Bristol began by saying that for a good many industrial purposes the temperatures employed range from 2000 degrees Fahr. downward. For such temperatures the durabilitiy and reliability of his instrument had been demonstrated, and while he considered it applicable to higher temperatures, he would not speak with assurance of such applications. He described the work of others in this field, referring more especially to the Chatelier pyrometer, with which he contrasted his own. The Chatelier is essentially a high-resistance and hence delicate instrument. The thermo-couple is composed of platinum and platinum alloy, making it expensive, while the current being feeble, the galvanometer needle must have a filament suspension, making it a delicate instrument. Moreover, it must be permanently and substantially mounted. In the speaker's instrument the couple is composed of various combinations of tungsten, steel, nickel, iron and copper, the combination used depending on the scale of temperature to be covered. The entire apparatus, including the recording instrument, is of low resistance, the current being comparatively heavy and making it practicable to use substantial jeweled pivot bearings in the recording instrument, which is, in fact, of the Weston type and may be hung anywhere or may be encased in a box for portability. No rare metals being used in the couples, they are of low cost and substantial size, and may be used in large numbers, the couples being inserted in various parts of the furnace and connected by switches to a common recording instrument. In this connection diagrams of nineteen couples inserted in various places in boiler flues were shown and in connection therewith diagrams showing the progressive fall of temperature were exhibited. The couples are made in sections so that the end exposed to the high temperature may be renewed when necessary, at slight expense. The entire couple is of such length as to reach to the floor, where it is influenced but little by the heat of the furnace. The insulation of the couple is by asbestos and carborundum paint and is thus both cheap and free from danger of accident. The sensitiveness may be indefinitely increased by joining couples in series, a striking exhibition being made of such an instrument, which responded promptly and decisively to the warmth of the hand.

When used for determining the temperature of melted metals—as, for instance, a lead bath—the hot ends are not joined, the electric connection being made by the melted metal. This use of the instrument has many applications; for example, to hardening steel and to determining the temperature of melted brass and bronze.

The readings of the instrument give the difference in temperature between the hot and the cold ends, which latter cannot well be kept constant, and a beautiful compensating device has been provided to offset the effect of varying temperatures of the cold end. This consists of a thermometer bulb with a short and comparatively large tube, in which is a loop of platinum wire, the lower end of which dips in the mercury. This is placed in proximity to the cold end of the couple, where it has the same temperature. As the temperature rises the mercury rises in the tube with it and thus short-circuits a portion of the platinum loop and cuts its resistance out of the circuit and *vice versa*. The compensation is exact for any one temperature which may be chosen and approximate for other temperatures.

In addition to the advantages of the low-resistance type of instruments that have been given are the further advantages that they permit the use of dead-beat recording instruments, making the reading almost instantaneous, whereas with the high-resistance type each change of temperature leads to oscillation of the needle, which must be allowed to come to rest before readings are taken, and that by varying the resistance in circuit the same couple may be used for different ranges of temperature. Moreover, the compensator is possible with this instrument only.

The instrument has already found large application to lead hardening and galvan-

izing baths and to the melting of lead for making shot. After weeks and even months of use the indications of the instrument are found to be unchanged.

The discussion was opened by a written communication from R. H. Penny, of the Winchester Repeating Arms Company, who had made large use of the instrument in annealing, hardening, bluing, etc., and found that it left little to be desired. While speaking highly of the Chatelier instrument, which he had also used, he regarded this as far superior to it for industrial purposes. It places the furnaces under absolute control and enables them to be worked like machines. To illustrate the usage which the instrument will withstand, he described some experiments to determine the temperature at which cartridges explode. A couple was inserted in a box among the cartridges, the whole being heated until the cartridges exploded. After the explosion the couple was found, of course, to be badly damaged mechanically, but the readings of the instrument as the explosions took place gave no indication that anything unusual was happening.

Professor Kent pointed out in a written discussion the ever increasing importance of high temperature determinations and gave several applications of the instrument.

Mr. Carey considered that no field of work offered more promise than this. He pointed out how much high-temperature work depended on the skill of workmen who were indispensable to the success of operations, and who frequently lorded it over their employers in an unbearable way. He also gave a sketch of the history of high-temperature measurements.

Mr. Uehling then gave a description of the Uehling and Steinhart pneumatic pyrometer, the principle of which is also applicable to the determination of the percentage of CO_2 in furnace gases, and he exhibited a diagram of readings from two instruments attached to a furnace, showing that the temperature and the percentage of CO_2 fluctuated in unison with each other as the condition of the fire varied, the opening of the door and the supply of fresh coal being especially marked.

Mr. Henning said that Profeessor Bristol had not explained all his instruments, and added that he had made his instrument to automatically record furnace temperatures. He exhibited some record charts from the recording form of instrument.

The general condition of business in the country is best shown perhaps by the recent report of the United States Steel Corporation, according to which the amount of unfilled orders now on the books of the corporation is greater than at any previous time. The earnings of this company for the year 1905 have been announced at $119,850,282, which were exceeded by only one previous year, which was 1902, when they were $133,308,000.

Personal.

Will the contributor who sent us "A Little Problem in Geometry" kindly send to the editor his name and address?

Charles A. Rumpf, for forty-four years foreman of the Pennsylvania Railroad machine shops at Harrisburg, retired recently. He was tendered a reception in the Railroad Young Men's Christian Association building.

Howard A. Knauss, superintendent of the Crane Iron Works at Catasauqua, Pa., recently resigned to become superintendent of the Northern Iron Works at Standish, N. Y. He received from the Crane workmen as a mark of esteem a fine diamond ring.

Arthur Falkenau, after having been engaged for about twenty-five years in Philadelphia in a manufacturing and engineering business, has retired from that business and has opened an office as consulting engineer and expert at 920 Witherspoon Building, Philadelphia.

Our contributor, Edward R. Markham, who has had a large experience in manufacturing operations, will open an office at 66 Dana street, Cambridge, Mass., where he will give advice regarding shop equipment, designing of special machinery and tools, selection of stock for various purposes, methods of hardening and case-hardening, etc.

Obituary.

Frederick T. Towne, son of Henry R. Towne and general superintendent of the Yale & Towne Manufacturing Company's plant at Stamford, Conn., died suddenly in Stamford, February 4, of Bright's disease.

Henry Martyn Lewis, president for over twenty years of the S. S. White Dental Manufacturing Company, died January 26 of heart disease at his home in Germantown, Pa. He was 74 years of age.

Lord Masham (Samuel Cunliffe-Lister), the patentee of many inventions, including a compressed-air brake for railroads and a wool-combing machine, died February 2 at Swinton Abbey, Masham Yorkshire, England. The *New York Times* gives the following condensed account of his career: Lord Masham's career was a remarkable one. He died one of the richest men in England after triumphing over obstacles which would have daunted ninety-nine out of a hundred inventors, and which more than once threatened him with complete ruin. He was born in 1815, and when he was 23 years old he and his brother started a small business at Manningham, Yorkshire, as worsted spinners and manufacturers. Samuel Cunliffe-Lister was of an inventive turn of mind, and was continually experimenting with new ideas. Before long he had taken out several patents, some of which proved quite profitable. He continued to experiment with other inventions, and he lost more than one fortune before he perfected his famous wool-combing machine. It was not until the sixties that he succeeded, but when the patent was obtained and the machines were set going the profits were enormous, the product of the machine being worth thirty or forty times the cost of the raw material worked up. For many years the profits from the business amounted to over $1,000,000 annually. It is said that at one time Lord Masham spent $5,000 a day in experiments with his inventions.

Manufacturers.

Afton, Iowa, will erect an electrical street lighting plant.

The Belleville (Ill.) Stove and Range Company will enlarge its plant.

A. G. Whitney, St. Cloud, Minn. is having plans prepared for a large gas plant.

The T. B. Wood's Sons Company, Chambersburg, Pa., has put up a new store house.

The Ornamental Wire Weaving Company, Philadelphia, Pa., will move to Camden, N. J.

The Corr Manufacturing Company, Taunton, Mass. cotton goods, will increase the capacity of its plant.

The plant of the McFeely Brick Company at Latrobe, Pa., has been destroyed by fire. Loss about $100,000.

The Keystone Leather Company of Camden, N. J.. is having plans prepared for a factory in Bristol, Pa.

The American Waltham Watch Company of Boston, Mass. is planning for an extensive addition to its plant.

The W. T. C. Macallen Company, Boston, Mass., manufacturing insulating material, is erecting a new factory.

The Sheffield (Ala.) Steel Range & Stove Company has been formed. Capital $50,000. President, John Donk, Jr.

The George D. Witt Shoe Company, Lynchburg, Va. is erecting a new factory to be equipped with the latest machinery.

The Foyer Manufacturing Company, makers of scales, letter-presses, etc., Chicago, Ill. will erect a factory in Sturgis, Mich.

A three-story addition will be built to the plant of the Thomas-Roberts-Stevenson Company stove founders, Philadelphia, Pa.

The Parkersburg, (W. Va.) and Ohio Valley Electric Railway Company has let contract for the erection of power houses.

Landers, Frary & Clark, cutlery and hardware, New Britain, Conn., have taken out a permit for a factory addition to their plant.

The Chambersburg (Pa.) Hosiery Company has erected a new mill to double its output. Electricity is to be the motive power.

The Plankinton Packing Company, Milwaukee, Wis. will spend $40,000 in improvements to its plant. Modern machinery will be installed.

John L. Kuser and a number of other capitalists of Trenton, N. J. have about completed arrangements for the erection of an automobile factory.

It is said the Westinghouse Machine Company of E. Pittsburg, Pa. will probably increase its plant and engage in the manufacture of automobiles.

The U. N. Roberts Company, Davenport, Iowa, sashes and doors, has under consideration plans for a new factory building adjoining its present plant.

The Chicago, Milwaukee & St. Paul Railroad Company, will spend $500,000 rebuild-

ing its yards, depots, shops, roundhouse etc., in La Crosse, Wis.

Drummond & Company, Reading, Pa., have awarded contract for the erection of a rolling mill building, which will be equipped with up-to-date machinery.

It is reported that the Fuller Construction Company, of New York, will erect a factory in Bridgeport, Conn., for the manufacture of automobiles of a French type.

An explosion wrecked the boiler and engine house, and damaged the plant of the Annis Grain & Lumber Company, Londonderry, N. H., causing a loss of $10,000.

The American Post Company is being organized at Bloomfield, Ind. with a capital of $40,000. The directors are Francis Dugger, Joe Mors and others of Bloomfield.

Fire in the plant of F. E. Myers & Bro., Ashland, Ohio, makers of pumps etc. was confined to the storage and shipping rooms only, and shipments will be delayed but one week.

The Miller Foundry and Specialty Company, recently incorporated with a capital of $30,000, has decided to locate in North Tonawanda, N. Y., where a site has been secured.

The Banner Manufacturing Company, of Hamler, Ohio, has been incorporated for $200,000, and will erect a plant for the manufacture of elevator buckets. A. M. Jackson, president.

The Burtt Manufacturing Company, Kalamazoo, Mich., builder of automobiles, is having plans prepared to more than double the capacity of the plant. About $50,000 will be expended.

The Niagara Motor Boat Company, of North Tonawanda, N. Y., has been incorporated, and has started to erect a factory. C. V. Trombley M. & L. Clapham, of North Tonawanda, and others, incorporators.

The Crucible Steel Company of America has perfected plans for the erection of a large new steel plant in Pittsburg, Pa. It is also announced that the company will enter into the manufacture of railroad springs.

The Granite City Bottling Works, a new company will establish a plant in St. Cloud, Minn., to be operated by electricity and equipped with modern machinery. M. Witte and Fred Witte of Atwater, Minn. are stockholders.

The steel works plant of the Benjamin Atha Company, Newark, N. J., is to be extensively enlarged. The improvements, which will cost about $80,000 will include a new foundry, an addition to the present foundry and a gashouse.

The Electric Cable Company of Bridgeport, Conn. has been formed, which succeeds the Magnet Wire Company and the Peerless Electric Company of New York. A factory is being erected in Bridgeport for the manufacture of magnet wire, field and armature coils and voltax, a new non-rubber insulation. The New York office is at 42 Broadway.

New Catalogues.

Scully Steel & Iron Co., Chicago, Ill. Stock list for January and February, 1906. Illustrated, 4½x7, pp. 144, paper.

Gisholt Machine Co., Madison, Wis. Leaflet describing and illustrating motor driven tool grinder and 36" vertical boring mill with belt feed.

The "Ideal" Automatic Pump Governor Co., 15-25 Whitehall St., New York. Catalogue describing governor made by this company. Illustrated, 6x9, paper.

Cornell University, Ithaca, N. Y. Register for 1905-1906. This is quite a voluminous book giving details of the different departments. 5x7½, pp. 639, paper.

United Engineering & Foundry Co., Pittsburg, Pa. Very attractive catalogue, describing roll turning lathes and containing list of users. Illustrated, 8½x10, pp. 12, paper.

Niagara Tachometer & Instrument Company, Niagara Falls, N. Y. Catalogue of the different types of tachometers made by this company. Illustrated. 5x7, pp. 19, paper.

Webster & Perks Tool Co., Springfield, Ohio. Illustrated and descriptive catalogue and wholesale list prices of Simplex trimmers and paper hangers' tools. 4½x7½, pp. 23, paper.

Westinghouse Electric & Manufacturing Company, Pittsburg, Pa. Circular No. 1127, illustrating and describing control apparatus and trolleys for single-phase railway systems.

Jenkins Bros., 71 John street, New York. Pamphlet illustrating and describing extra heavy valves for pressures above 150 pounds. This also contains table of dimensions. 5x8, paper.

The H. A. Bubb Pulley Company, Williamsport, Pa. Catalogue No. 3, containing illustrations and price lists of the compression hub pulley made by this company. 3½x6, pp. 24, paper.

Fairbanks, Morse & Co., New York, Chicago and elsewhere. Catalogue No. 101A, describing Sheffield gasoline inspection motor cars and other cars for railroad service. 6x9, pp. 16, paper.

Detroit Screw Works, Detroit, Mich. Current price lists used by the milled machine screw manufacturers of the United States and catalogue of specialties. Illustrated. 6x9, pp. 65, paper.

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat free. E. G. Smith, Columbia, Pa.

Cox Computers, 75 Broad st., New York.

Wire and sheet metal working machinery and tools. Emmons Collins, Chicago, Ill.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Parallel attachments for drawing tables. F. G. Hobart, Beloit, Wis. Dealers or by mail.

Working drawings. Experimental work. Geo. M. Mayer, M. E., 1131 Monadnock, Chicago, Ill.

Light and fine mach'y to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Wanted—Two or three second-hand Potter & Johnston Automatic Turret Lathes in good condition. Box 102, AMER. MACH.

Want to buy September 3, 1903, and November 26, 1903, issues of AMERICAN MACHINIST. Box 93, AMERICAN MACHINIST.

Pneumatic and mechanical engineer desires to represent firms in Scotland. Charles Sangster, Pittodrie Place, Aberdeen, Scotland.

Work wanted for a Cleveland automatic lathe; handles 2 in. and under. The Earle Gear and Machine Co, 141 Oxford st., Philadelphia.

Andorn & Martin, consulting engineers, will develop your ideas, put your inventions into marketable shape. 25 West 15th St., New York City.

Wanted—To build special machinery, jigs, fixtures, punches, dies, power press tools and machine work. Accurate work guaranteed. Chas. S. Dexter, Attleboro, Mass.

Wanted—Set of reference books on Mechanical Drawing. Published by Scranton International Correspondence School. State lowest cash price for reference books only. J. 122, AM. MACH.

Wanted—AMERICAN MACHINIST for each of the following dates: July 7th, August 4th, October 27th, 1904; June 1st, September 7th, November 2, 1905. Address A. A., Drawer 5094, Boston, Mass.

Wanted—Good live agents all over country to sell our make of cranes; also all classes of tramways; we erect complete; those having established trade desired. Yeo Bros., Philadelphia, Pa.

Wanted—One Belted Generator 125 or 150 K. W. 250 Volts D. C. about 500 to 600 R. P. M. Must be in first-class condition. Reply, stating price and full particulars to Box 132, AMER. MACH.

Tool Catalogue No. 22. 950 pages, bound in cloth. Greatest small tool catalogue ever published. Will be sent post-paid on receipt of $1. Money paid for catalogue refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton st., New York City.

For Sale.

For Sale—One No 1 Bardons & Oliver screw machine, nearly new. Brown Machine Co., Ltd., Battle Creek, Mich.

For Rent—Small factory at Plainfield, gasolene engine, railroad siding, $25 per month. A. J. Brunson, Plainfield, N. J.

For Sale—Small machine shop in thriving N. E. village. Good opening for man with small capital. Box 26, AMER. MACH.

Pattern shop in New York for sale; good tools, location and trade; $800. Grand opportunity for pattern maker. "Bargain" 150, AMER. MACH.

For Sale—10-ton crane, 40 ft. span, rope drive; has been tested to 20 tons; very low price for cash. Address Murray Iron Works Co., Burlington, Iowa.

For Sale—Rolls for flattening wire, and new hollow column sander with two discs, cheap. Shafting Straighteners 2 to 5 inch. American Machinist '82 to '02, complete and broken volumes. J. H. Wells, Tampa, Fla.

For Sale—Gas engine business with engines from two to sixty horse power capacity. Stock of finished and unfinished engines and patterns, drawings, etc. Will sell at a bargain. Apply Box 55, AMERICAN MACHINIST.

For Sale—Entire plant of Philadelphia's best known Tamashanta Mill; machinery in perfect order and ready to operate; bankrupt sale; machinery, good will and office furniture will be sold at a sacrifice; immediate possession can be given. Edward M. Bernstein, Attorney, 209 Broadway, New York city.

Business Opportunities.

Wanted—Machine shops or capital, to take up manufacturing of cutters and reamers on a new, patented principle. Address Box 149, AMER. MACH.

Old, successful foundry business wants good active business partner who will buy interest. Net annual earnings $8700. Volume $128,000. Capital $33,000. Box 135, AMER. MACH.

M. E., owning patents on rotary pump or blower of high efficiency and low cost would like to meet party with capital to build and market same. Machine has been tested and is no experiment. Box 148, AMER. MACH.

High-grade automobile company want partner who can be estimater and designer of their special automobiles built for business purposes only. Must invest $5000 or $10,000 and have good references. Box 134, AMER. MACH.

Wants.

Situation and Help Advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded; but replies will not be returned. If not forwarded they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted.

Classification indicates present address of advertiser, nothing else.

CONNECTICUT.

Hustling young American, good education and business ability, desires position as foreman or inspector on gear job, March 1. Box 126, AMER. MACH.

ILLINOIS.

Wanted—Position as chief draftsman or assistant superintendent for shops building steam or gas engines and a general class of work. Practical machinist and tool maker and a technical graduate, with broad experience. Box 143, AMER. MACH.

MARYLAND.

Mechanical Engineer with many years shop experience and a designer of ability desires a position where ability will be recognized and rewarded. Has developed inventors' ideas into paying patents and is a specialist on automatic machinery. Understands handling men and shop problems. Box 127, AM. MACH.

NEW JERSEY.

Mechanical draftsman, graduate, several years' experience as designer on pumping engines and condensers, desires change. Box 104, AMERICAN MACHINIST.

Engineering designer seeks position; Corliss engines, pumping and blowing engines, gas engines, power stations. American, extensive experience, inventive, accurate, good habits; competent to take charge. Box 88, AMERICAN MACHINIST.

NEW YORK.

Wanted—Position for developing automatic machinery or other original work. Box 145, AMER. MACH.

Designer of multiple cylinder gas and producer gas engines would like to make a change. Box 147, AMER. MACH.

Machine designer capable of developing special small machinery for manufacturing desires position. Wide experience. Box 120, AMER. MACH.

A skilled mechanic and designer desires position where the development of machines and tools for economical production is desired. Box 121, AMERICAN MACHINIST.

Draftsman—Young man 25, foreigner, technical graduate, desires position, mechanical or electrical. Location no object. American experience. Box 146, AMER. MACH.

General foreman, 36, successful in handling men and work to best advantage, varied experience in high grade machinery Expert machinist. Box 23, AMERICAN MACHINIST.

Machinist and toolmaker would like to have responsible position in manufacturing concern. Fully acquanted with the manufacturing business. Steady and sober. Box 123, AMERICAN MACHINIST.

Situation wanted by Electrical Engineer, technical graduate, 4 years experience in electrically equipping machine shops and machine tools. One year in testing electrical apparatus. Box No. 136, AMER. MACH.

A young man (29) who has had a technical education and eight years experience selling Machine and Electrical tools wants to represent one or two manufacturers in New York City. Advertiser has many personal acquaintances among machine tool dealers and users and is at present representing one firm, whom he is privileged to offer as reference. Office is in centre of machinery district, and would be conducted as New York office of parties represented, on either salary or commission basis. Box 137, AMER. MACH.

OHIO.

Superintendent wishes change. A technical graduate with 15 years experience in heavy machine work, steam and gas engines, and pumping machinery. Thoroughly familiar with modern methods, machine shop design and construction, electrically driven tools, etc. Box 124, AMERICAN MACHINIST.

PENNSYLVANIA.

General Foreman experienced and up-to-date in modern machine shop methods; very successful in handling men and reducing cost. Box 140, AMER. MACH.

A first-class mechanical draftsman is open for employment, 12 years experience in Cortis engine and compressor works. A-1 references. Box 139, AMER. MACH.

Draftsman, mechanical, 23, experienced detailer, air compressors, hydraulic and special machinery. Steel-plant work preferred; presently engaged. Address "Push," 144, AMER. MACH.

RHODE ISLAND.

Wanted—Position as foreman of hand and automatic screw machines. Competent to design cams and tools and superintend making of same. References. Box 125, AMER. MACH.

Help Wanted.

Classification indicates present address of advertiser, nothing else.

ILLINOIS.

Draftsman—We have positions now open for draftsmen. Call or address Western Electric Co., Chicago, Ill.

Wanted—Draftsmen—Men accustomed to interchangeable work on small tools, jigs and fixtures. Western Electric Company, Chicago, Ill.

Turret lathe man—Experienced man on heavy turret lathes to take charge of department. Must have had experience in similar position. State experience fully; whether married or single. This position presents a good opportunity for the right man. Address Box 97, AMERICAN MACHINIST.

MICHIGAN.

Wanted—A first-class outside erector, experienced on electric traveling crane work. Must be able to take full charge of the job and show results. Box 58, AMER. MACH.

NEW JERSEY.

Wanted—A first-class mechanical draftsman; state experience and salary wanted. Box 881, AMERICAN MACHINIST.

Salesman to sell product of Automatic screw machines. Must be good salesman and practical factory man capable of figuring on screw machine work. A. B. C., 142, AMERICAN MACHINIST.

We are increasing our tool-making department and solicit applications from toolmakers and machinists who are experienced on fine and complicated work. Apply to Victor Talking Machine Co., Camden, N. J.

Wanted—General Foreman by manufacturing company employing about 100 hands, vicinity of Newark, N. J. Must be a thorough mechanic, capable of handling men and willing to assume responsibility. Address Box 130, AMERICAN MACHINIST.

NEW YORK.

Wanted—Draftsmen for jigs, fixtures, dies and shop tools. Apply to Mergenthaler Linotype Co., Brooklyn, N. Y.

Wanted—First-class pattern maker. State wages and experience. Location Brooklyn. Box 129, AMER. MACH.

Wanted—Experienced assemblers for clock work; drill press and bench workers; in instrument factory. State experience and salary wanted. Box 119, AMER. MACH.

Wanted—Two or three first-class lathe hands; also one vertical milling machine man. Steady work and highest wages to good men. Box 77, AMERICAN MACHINIST.

Wanted—Draftsman capable of designing small tools. Must be familiar with punch press work. State experience and salary expected. Box 107, AMERICAN MACHINIST.

Wanted—Experienced draftsmen, first-class machinists, toolmakers and gage makers; give detailed experience, references, age and wages expected. Remington Arms Company, Ilion, N. Y.

Draughtsman—Wanted a first-class mechanical draughtsman. Steady work and liberal pay to a competent man. Address, giving experience, salary required, etc., Box 141, AMERICAN MACHINIST.

Wanted—Foreman for planing and milling machine department. Must be capable of getting best results from up-to-date tools. State age, past experience and wages expected. Box 86, AMERICAN MACHINIST.

Wanted—Strictly first-class foreman for steel car plant. Must have all-around ability of mechanic. Not over 35 years of age; familiar with keeping costs, controlling men and a hustler. Box 54, AM. MACHINIST.

Cost clerk wanted for moderate size manufacturing plant, making light, interchangeable machinery. Pleasant location. Write giving age, full experience in this line of work, and salary expected J. M. M., AM. M.

Wanted—Factory stores clerk; must be energetic and familiar with all supplies and materials used in the manufacture of firearms; give detailed experience, age, references and salary expected. Remington Arms Company, Ilion, N. Y.

Wanted—Foreman for the lathe department. Young man who has had experience on light and heavy accurate work. Must be capable of handling 75 men. State age, past experience and wages expected. Box 85, AMERICAN MACHINIST.

Wanted—Five detail draftsmen with at last two years' drafting experience, for position with reliable firm in New York City. Previous experience in our line not essential. State age, nationality and salary. "Drafting," AMERICAN MACHINIST.

Wanted—By large manufacturing concern, competent man to take charge of inspection of small interchangeable parts. Must have practical shop experience. (Fire-arms preferred.) Give experience in detail, age, references and salary expected. Box 71, AM. M.

Wanted—Assistant Superintendent for large manufacturing works, located in the East, engaged in the manufacture of high grade, light interchangeable work. Must be a good mechanic with broad experience in handling men and capable of directing fixture and small tool design. Address X. Y. Z., 131, AMER. MACH.

Wanted—Foreman to take charge of small machine shop in New York City, with manufacturing concern building machines for its own use exclusively. Must be thoroughly up in modern machine methods, systematic and able to get work out at least cost consistent with care and accuracy. Steady position for intelligent, capable, and reliable man. None others need apply. Write, stating previous experience, wages and references, Box 87, A. M.

OHIO.

Wanted—Three or four first-class operators on Cleveland Automatic machines by a concern near Cleveland. Box 84, AM. MACH.

Wanted—Designer and draftsman for punch presses, power squaring shears and drop hammers. Box 92, AMERICAN MACH.

Draftsmen Wanted—Two or three first-class draftsmen, familiar with heavy engine design. Apply or address The William Tod Co., Youngstown, Ohio.

Wanted—First-class man to take charge of designing of up to date jigs and fixtures for machine tool work. Must be capable of giving instructions in use of same. None but parties having practical shop experience need apply. State experience and salary wanted. Address Cincinnati Milling Machine Co., Cincinnati, O.

PENNSYLVANIA.

Wanted—High-grade erecting machinists for air compressor work.—The Blaidsdell Machinery Co., Bradford, Pa.

Wanted—First class floor hands with experience in assembling machine tools. Apply Stoever Foundry & Manufacturing Co., Myerstown, Pa.

Wanted—Several first-class vertical boring mill hands, accustomed to large work. Apply Employment Department, Westinghouse Electric & Manufacturing Co., East Pittsburg, Pa.

Wanted—Technically educated engineer having had experience in such work, to take charge of Engineering Department of a concern making gasolene automobiles. State age, experience, references and approximate terms. Address, Box. 91, AM. MACH.

Wanted—An operator for Gisholt machine. Must thoroughly understand rapid production of all castings within machine's capacity. State age, experience, reference and salary expected. Good position for first-class man. Address H. L. B. Box 452, Pittsburg, Pa.

Wanted—Native of Great Britain to act as Sales Agent and to devote his entire time to representing the United States makers of a steel specialty used in manufacturing plants. State salary expected and give full particulars as to age, experience, references, etc. Box 133, AMER. MACH.

Applications are wanted from general engineering draftsmen by a large engineering firm to establish a file from which applicants can be selected. Enclose copies of references, engineering and drafting experience, education and salary expected. Address Box 117, AMER. MACH.

Draftsmen—We need immediately for permanent positions now open, experienced draftsmen on machine tools, air and electrically driven machinery, rolling mill machinery, blast furnace work, boilers, stokers, etc., salaries $75-$150. Write immediately. The Engineering Agency, Inc., 703 Diamond Bank Bldg., Pittsburg, Pa.

RHODE ISLAND.

Wanted—First-class draftsmen on special tools, jig and fixture work for light high grade machinery. Apply to The Taft-Peirce Mfg. Co., Woonsocket, R. I.

Toolmakers Wanted—First-class workmen on jig and fixture work for light high grade machinery. Permanent employment to competent workmen. Apply to the Taft-Peirce Mfg. Co., Woonsocket, R. I.

WISCONSIN.

Wanted—A practical and thorough up-to-date mechanic as superintendent of a large traction engine plant. Address Box 128, AMER. MACH.

Wanted—To meet with our constantly increasing requirements, we invite applications from first-class machinists, moulders and pattern makers. Giddings & Lewis Mfg. Co., Fond du Lac, Wisconsin.

Wanted—Foreman who is thoroughly experienced in the manufacture of chucks, to take charge of work. Must be able to undertake and carry through the entire shop work on a line of this kind. Must be sober, steady and a pusher. State experience, with whom, age, married or single, and pay expected. Address box 118. AMER. MACH.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen, with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters ackowledged and held confidential. Box 919, AM. M.

WEST OF MISSISSIPPI.

Wanted—A man of genius with large experience to make all kinds of small tools for drill, screw and milling machine work; also to act as foreman in a fine instrument shop. Box 138, AMER. MACH.

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McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Poole Co., J. Morton, Wilmington, Del.
Prentiss Tool & Supply Co., New York.
Ridgway Mach. & Tool So., Ridgway, Pa.
Vandyck Churchill Co., New York.
Warner & Swasey Co., Cleveland, Ohio.

Boring Tools

Armstrong Bros. Tool Co., Chicago, Ill.

Brackets, Lamp

Standard Welding Co., Cleve., O.

Bulldozers

Prentiss Tool & Supply Co., New York.

Cabinets, Tool

Armstrong Bros. Tool Co., Chicago, Ill.

Calipers

Starrett Co., L. S., Athol, Mass.

Cams

Boston Gear Works, Boston, Mass.

Carborundum

See Grinding Wheels.

Castings, Brass and Bronze

Nolte Brass Co., Springfield, O.
Phosphor Bronze Smelting Co., Philadelphia, Pa.

Castings, Die Molded

Franklin Mfg. Co., Syracuse, N. Y.

Castings, Iron

Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Massey Mach. Co., Watertown, N. Y.
Poole Co., J. Morton, Wilmington, Del.
United Engineering & Fdry. Co., Pittsburg, Pa.
U. S. Foundry & Sales Co., South Norwalk, Conn.
Yale & Towne Mfg. Co., Stamford, Conn.

Castings, Steel

Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Kent & Co., Edwin R., Chicago, Ill.

Cement, Cast Steel

Clark Cast Steel Cement Co., Shelton, Conn.

Centering Machines

Hendey Mach. Co., Torrington, Conn.
Hill, Clarke & Co., Boston, Mass.
Phoenix Mfg Co., Hartford, Ct.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Machine Co., D. E., New London, Conn.

Centers, Planer

Morse Twist Drill & Mach. Co., New Bedford, Conn.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving

Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Boston, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Jeffrey Mfg. Co., The Columbus, Ohio.
Link-Belt Engr. Co., Phila., Pa.
Morse Chain Co., Trumansburg, N. Y.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold

Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines

American Tool Works Co., Cincinnati, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Mach. Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co, R. K., Cincinnati, O.
Potter & Johnston Mach. Co., Pawtucket, R. I.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Chucks, Drill

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Ct.
Goodell-Pratt Co., Greenfield Mass.
Horton & Son Co., The E., Windsor Locks, Conn.

Chuck Drills—*Continued.*

Jacobs Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach Co., New Bedford, Mass.
Niles-Bement-Pond Co.,New York.
Pratt Chuck Co., Frankfort, N. Y.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co, Greenfield, Mass

Chucks, Lathe

Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg Co., New Haven, Conn.
Horton & Son Co., The E., Windsor Locks, Conn.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer

Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.

Chucks, Split

Rivett Lathe Mfg. Co., Boston, Mass.

Circuit Breakers

Crocker-Wheeler Co., Ampere, N. Y.
Cutler-Hammer Clutch Co., Milwaukee, Wis.
General Elec. Co., New York.
Stanley G. I. Elec Mfg. Co., Pittsfield, Mass
Switchboard Equipment Co., Bethlehem, Pa.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Clamps

Billings & Spencer Co., Hartford, Conn.

Clutches, Friction

Caldwell, Son & Co., H. W., Chicago, Ill.
Cresson Co., Geo. V., Phila, Pa.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Engineering Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., N. Y.
Reeves Pulley Co., Columbus, Ind.
Wood's Sons, T. B., Chambersburg, Pa.

Clutches, Magnetic and Electrical

Cutler-Hammer Clutch Co., Milwaukee, Wis.

Coal Handling Machinery

Link-Belt Engineering Co., Philadelphia, Pa.

Coils

Standard Welding Co., Cleve., O

Compound, Boiler

Advance Mfg. Co., Kalamazoo, Mich.

Compound, Pipe Joint

Dixon Crucible Co., Jos., Jersey City, N. J.

Compressors, Air

Blaisdell Mchy. Co., Bradford, Pa.
Blanchard Mach. Co., Boston, Mass.
Bury Compressor Co., Erie, Pa.
Curtis & Co., Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Hoermann, A. E., New York.
Ingersoll-Rand Co., New York.
Mietz, August, New York.

Compressors, Gas

Ingersoll-Rand Co., New York.

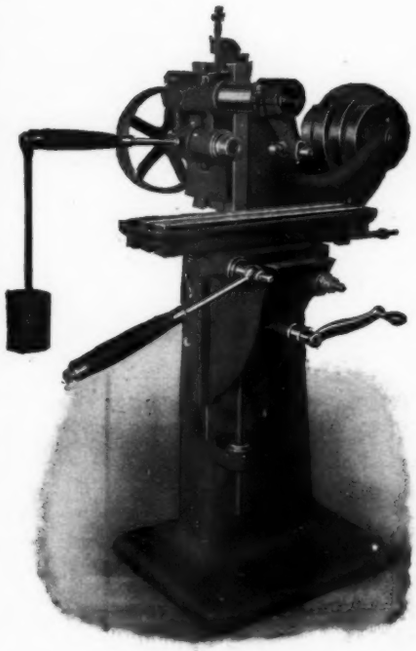
Condensers

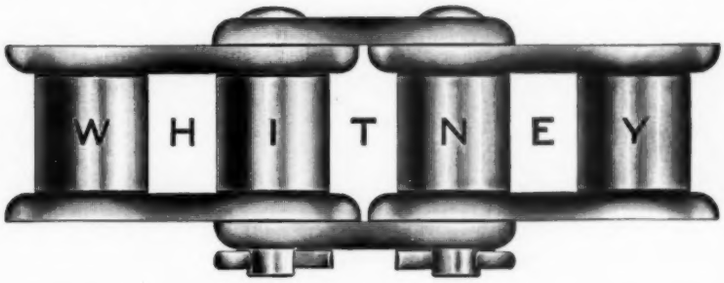
Stanley G. I. Elec. Mfg. Co., Pittsfield, Mass.

Conduit, Interior

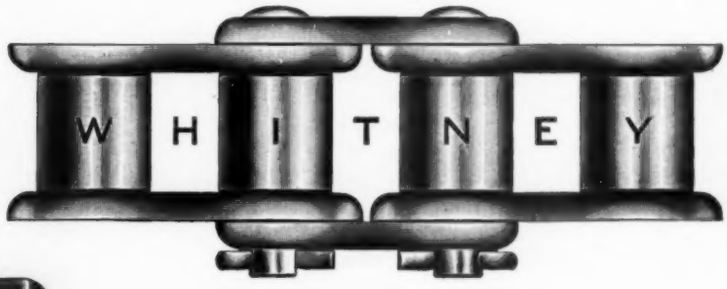
Sprague Elec. Co., New York.

"WIZARD" Chains and Sprockets—Patented

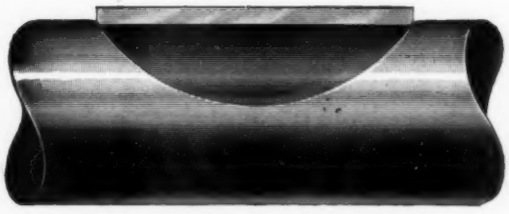




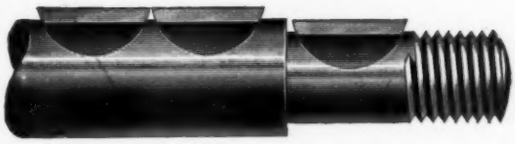
1906 Model "Whitney" Detachable Roller Chains—Patented



Block Chains



"Woodruff" Patent Keys



Three Popular Specialties

"Whitney" Chains
Hand (feed) Milling Machines
The Woodruff Patent System of Keying

THE WHITNEY MFG. COMPANY

HARTFORD, CONN., U.S.A.

FOREIGN AGENTS: C. W. Burton, Griffiths & Co., Great Britain. Schuchardt & Schutte, Germany, Austria, Holland, Russia and Scandinavia. Fenwick, Freres & Co., France, Belgium, Italy, Switzerland, Spain and Portugal.

Cones, Friction
Evans Friction Cone Co., Boston, Mass.

Connecting Rods and Straps
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work
Blanchard Mach. Co., Boston, Mass.

Controllers and Starters, Electric Motor
Crocker-Wheeler Co., Ampere, N. J.
Cutler-Hammer Clutch Co, Milwaukee, Wis.
General Elec. Co., New York.
Stanley G. I. Electric Mfg. Co., Pittsfield, Mass.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Coping Machines
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Correspondence Schools
See Schools, Correspondence.

Cotters
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores
Morse Twist Drill & Mach Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.

Counters, Machinery
Veeder Mfg. Co., Hartford, Conn.

Countershafts
Almond Mfg. Co., T. R., Brooklyn, N Y.
Builders' Iron Fdry., Prov., R. I.
LeBlond Mach. Tool Co, R. K., Cincinnati, O.

Countershafts, Speed Changing
Cresson Co., Geo. V., Phila., Pa.
Gisholt Mach Co., Madison, Wis.
Reeves Pulley Co., Columbus, Ind.
Speed Changing Pulley Co., Indianapolis, Ind.

Counting and Printing Wheels
Franklin Mfg Co., Syracuse, N. Y.

Coupler, Hose
Ingersoll-Rand Co., New York.

Couplings, Shaft
Almond Mfg. Co., T R., Brooklyn, N. Y.
Caldwell & Son Co, H. W., Chicago, Ill.
Cresson Co., Geo V., Phila., Pa.
Link-Belt Engineering Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkesbarre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter Ltd., New York.
Standard Gauge Steel Co., Beaver Falls, Pa.
Woods Sons, T. B., Chambersburg, Pa.

Cranes
Alliance Machine Co., Alliance, Ohio.
Brown Hoisting Mach. Co., New York.
Case Mfg. Co., Columbus, O.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co., Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Maris Bros., Philadelphia, Pa.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Wm., Phila., Pa..
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

Cranes, Portable
Franklin Portable Crane & Hoist Co., Franklin, Pa.
Nicholls, Wm. S., New York.

Crank Pin Turning Machine
Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Crank Shafts
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles
Dixon Crucible Co., Jos., Jersey City, N. J.

Crushers
Ingersoll-Rand Co., New York.
Link-Belt Engineering Co., Philadelphia, Pa.

Cupolas, and Ladles, Foundry
Oberamyer Co., S. Cincinnati, O.
Paxson Co. J. W. Phila., Pa.
Stevens, F B., Detroit, Mich.

Cups and Covers, Oil
Bay State Stamping Works, Worcester, Mass.
Besly & Co. Chas. H., Chicago, Ill.
Elliott Chemical Works, Newton, Mass.
Winkley Co., Detroit, Conn.

Cut Meters
Warner Instrument Co., Beloit, Wis.

Cutters, Milling
Adams Co., Dubuque, Iowa
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Boker & Co., Hermann, New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Ingersoll Milling Mach. Co., Rockford, Ill.
International High Speed Steel Co., New York.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers, John M, Boat, Gauge & Drill Works, Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown &Sharpe Mfg. Co., Providence, R. I.
Fawcus Mach. Co., Pittsburg, Pa.
Hill, Clarke & Co., Boston, Mass.
Hurlburt-Rogers Mach. Co., South Sudbury, Mass.
Newton Machine Tool Works, Philadelphia, Pa.
Nutter, Barnes & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co., New York.

Cutting-off Tools
Armstrong Bros Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.

Diamond Tools
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Francis & Co., Hartford, Conn.

Dies, Sheet Metal
American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Kent & Co., Edwin R., Chicago,

Dies, Sub-Press
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening
Errington, F. A. New York.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Mch. Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.
Swaine Co., Fred J., St. Louis, Mo.

Dowel Pins
Winkley Co., Detroit, Mich.

Drawing Boards and Tables
Keuffel & Esser Co., New York.
Queen & Co., Phila., Pa.
Rich, J. & G., Phila., Pa.

Drawing Materials
Alteneder & Sons, Theo., Phila., Pa.
Kelsey, D., New Haven, Conn.
Keuffel & Esser Co., New York.
Queen & Co., Phila., Pa.
Rich, J. & G., Phila., Pa.

Draughting Machines
Universal Drafting Mach. Co., Cleveland, O.

Drift Bolt Drivers
Ingersoll-Rand Co., New York.

Drilling Machines, Bench
American Watch Tool Co., Waltham, Mass.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Goodell-Pratt Co., Greenfield, Mass.
Ingersoll-Rand Co., New York.
McGeorge & Sons, Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.

Drilling Machines, Boiler
American Tool Wks. Co., Cin., O.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drilling Machines, Multiple Spindle
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co, W. F. & John Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O
Fenn-Sadler Mach. Co., Hartford, Conn.
Foote, Burt & Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Garvin Mach. Co., New York.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Boston, Mass.
Marshall & Huschart Mchy. Co., Chicago, Ill.
McCabe, J. J, New York.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Three Rivers Tool Co., Three Rivers, Mich.

Drilling Machines, Portable
Cincinnati Elec. Tool Co., Cin., O.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drilling Machines, Radial
American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Detrick & Harvey Mach. Co., Baltimore, Md.
Dreses Mach. Tool Co., Cin., O.
Fairbanks Co., New York
Fitchburg Machine Works, Fitchburg, Mass.
Foote, Burt & Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
Marshall & Huschart Mach. Co., Chicago, Ill.
McCabe, J J., New York.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co., New York.

Drilling Machines, Turret
Niles-Bement-Pond Co., New York.

Drilling Machines, Upright
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co, W. F & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd, John, Dundas Ont., Canada.
Boynton & Plummer, Worcester, Mass.
Cincinnati Mach. Tool Co., Cincinnati, O
Fairbanks Co., New York.
Fenn-Sadler Mach. Co., Hartford, Conn.
Fosdick Mach Tool Co., Cincinnati, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
McCabe, J. J., New York.
Marshall & Huschart Mchry. Co., Chicago, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Vandyck Churchill Co., New York.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass
Whitney Mfg. Co., Hartford, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Drills, Center
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J T., Providence, R. I.
Standard Tool Co., Cleveland, O.

Drills, Hand
Cincinnati Electrical Tool Co., Cincinnati, O.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Pneumatic
Cleveland Pneu. Tool Co., Cleveland, O.
General Pneu. Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Rail
Foote, Burt & Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O

Drills, Ratchet
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Curtis & Curtis Co., Bridgeport, Conn.
Hisey-Wolf Mach. Co., Cincin., O.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers, Boat, Gauge & Drill Wks., John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock
Ingersoll-Rand Co., New York.
Northern Elec. Mfg. Co, Madison, Wis.

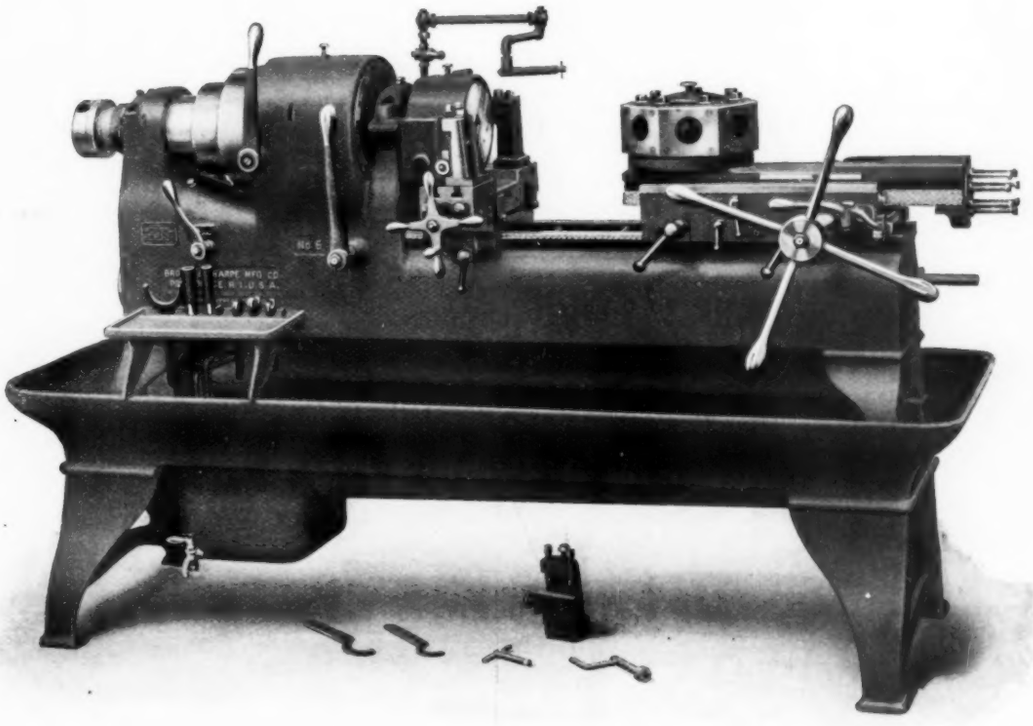
Drying Apparatus
Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos
C & C Elecric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
Eck Dynamo & Motor Works, Belleville, N. J.

Brown & Sharpe Manufacturing Co.,

Providence, R. I., U. S. A.

No. 6 Wire Feed Screw Machine. Range of Feeds .003″ to .034″ per Revolution of Spindle, adapts it to every variety of work within the capacity of the machine.



Features of the Variable Feeding Mechanism.

Driven direct from main spindle by chain and sprocket wheels.

Eight changes, varying in geometrical progression for each spindle speed.

Will pull any cut within the capacity of the machine.

Changes made without stopping the spindle or shifting the belt.

Special Circular, describing the Machine in detail, mailed to any address.

Dynamos —*Continued.*

Electro Dynamic Co., Bayonne, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin, O.
Northern Elec. Mfg Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Elec. Co., New York.
Stanley G. I. Elec. Mfg. Co., Pittsfield, Mass.
Sturtevant Co., B. F, Hyde Park, Mass.
Triumph Elec. Co., Cincin, O.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Dynamotors

Sprague Elec. Co., New York.

Electrical Supplies

Cutler-Hammer Clutch Co., Milwaukee, Wis.
Electro Dynamic Co, Bayonne, N. J.
General Elec. Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Elec. Co., New York.
Stanley G. I. Elec. Mfg. Co., Pittsfield, Mass.
Triumph Elec. Co., Cincinnati, O.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Electrically Driven Tools and Machinery

American Tool Wks. Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, O
Crescent Forgings Co., Oakmont, Pa.
Hisey-Wolf Mach. Co., Cincin., O.

Elevators

Albro-Clem Elevator Co., Philadelphia, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Harrington, Son & Co,. Edwin, Philadelphia, Pa.
Link-Belt Engineering Co., Philadelphia, Pa.
Morse, Williams & Co., Phila., Pa.

Emery Wheels

See Grinding Wheels.

Emery Wheel Dressers

Desmond-Stephan Mfg. Co., Urbana, O.
Francis & Co., Hartford, Conn.
Heald Machine Co., Worcester, Mass.
International Specialty Co., Detroit, Mich.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.

Enclosures, Tool-room

Merritt & Co., Philadelphia, Pa.

Engineers, Consulting and Mechanical

Dodge & Day, Philadelphia, Pa.
Roedder, O. C., Karlsruhe, Germany.

Engineers, Electrical

Crocker-Wheeler Co., Ampere, N. J.
Dodge & Day, Phila., Pa.

Engines, Automobile

Franklin Mfg. Co., Syracuse, N. Y.
Olds Gasoline Engine Works, Lansing, Mich.
Reeves Pulley Co., Columbus, O.

Engines, Gas and Gasoline

Automatic Mach. Co., Bridgeport, Conn.
Backus Water Motor Co., Newark, N. J.
Blaisdell Machinery Co., Bradford, Pa.
Brown-Cochran Co., Lorain, O.
Columbus Mach. Co., Columbus, O.
Foos Gas Engine Co., Springfield, Ohio.
Jacobson Mach. & Mfg. Co., Warren, Pa.
Mietz, August, New York.
New Era Engine Co., Dayton Ohio.
Olds Gasoline Engine Wks., Lansing, Mich.
Struthers-Wells Co., Warren, Pa.

Engines, Oil

Mietz, August, New York.

Engines, Steam

Buffalo Forge Co., Buffalo, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa
Struthers-Wells Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Engraving Machinery

Gorton Mach. Co., Geo., Racine, Wis.

Engravings

Springfield Photo-Engraving Co., New York.

Exhaust Heads

Sturtevant Co., B. F., Hyde Park, Mass.

Exhibition Machinery

Philadelphia Bourse, Phila., Pa.

Expanders, Boiler Tube

Nicholson & Co., W. H., Wilkesbarre, Pa.

Fans, Electric

Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Elec. Co., New York..
Stanley G. I. Electric Mfg. Co., Pittsfield, Mass.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Fans, Exhaust

Buffalo Forge Co., Buffalo, N. Y.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Feathers

Standard Gauge Steel Co., Beaver Falls, Pa.

Files and Rasps

Barnett Co., G & H., Phila., Pa.
Hammacher Schlemmer & Co., New York.
Nicholson File Co., Prov., R. I.
Richhelm & Co., E. P., New York.

Filing Machines

Detrick & Harvey Mach. Co., Baltimore, Md.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Henry & Wright Mfg. Co., Hartford, Conn.

Fillets, Leather

Cleveland Fillet Co., Cleveland, O.

Flexible Shafts

Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.

Forges

Boynton & Plummer, Worcester, Mass.
Buffalo Forge Co., Buffalo, N. Y.
Miner & Peck Mfg. Co., New Haven, Conn.
Ingersoll-Rand Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forgings, Drop

Billings & Spencer Co., Hartford, Conn.
Crescent Forgings Co., Oakmont, Pa.
Wyman & Gordon, Worcester, Mass.

Forgings, Hydraulic

Wyman & Gordon, Worcester, Mass.

Forgings, Steel

Baldwin Steel Co., New York.
Boker & Co., Hermann, N. Y.
Crescent Forgings Co., Oakmont, Pa.
Heppenstall Forge & Knife Co., Pittsburg, Pa.
Kent & Co., Edwin R., Chicago, Ill.
Tindel-Morris Co., Eddystone, Pa.
Wyman & Gordon, Worcester, Mass.

Foundry Furnishings

Adams Co., Dubuque, Iowa.
Ingersoll-Rand Co., New York.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.
Sturtevant Co., B F., Hyde Park, Mass.

Fuel Economizers

Sturtevant Co., B. F., Boston, Mass.

Furnaces, Annealing and Tempering

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.

Furnaces, Enameling

American Gas Furnace Co., New York.

Furnaces, Gas

Am. Gas Furnace Co., N. Y. City.
Chicago Flexible Shaft Co., Chicago, Ill.
Westmacott Co., J. M., Providence, R. I.

Furnaces, Melting

American Gas Furnace Co., New York.

Furniture, Machine Shop

Manufacturing Equip. & Engineering Co., E. Boston, Mass.
Merritt & Co., Philadelphia, Pa.
New Britain Mach. Co., New Britain, Conn.

Gas Blowers and Exhausters

Sturtevant Co., B. F., Boston, Mass.

Gauges, Recording

Bristol Co., Waterbury, Conn.

Gauges, Standard

Brown & Sharpe Mfg. Co., Providence, R. I.
Henry & Wright Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers, John M., Boat, Gauge & Drill Works, Gloucester City, N. J.
Slocomb Co., J T., Prov., R. I.
Starrett Co., L S., Athol, Mass.

Gauges, Steam

Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.

Gear Cutting Machinery

Adams Co., Dubuque, Iowa.
American Watch Tool Co., Waltham, Mass.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Bickford Drill & Tool Co., Cin., O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Morse, Williams & Co, Phila., Pa.
Newton Mach. Tool Wks., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Walcott & Son, Geo. D., Jackson, Mich.
Whiton Machine Co, D. E., New London, Conn.

Gear Testing Machinery

Gisholt Mach. Co., Madison, Wis.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Gears, Cut

Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Wks., Boston Mass.
Brown & Sharpe Mfg Co., Providence, R. I.
Caldwell & Son Co., H. W., Chicago, Ill.
Cresson Co., Geo V., Phila., Pa.
Davis, Rodney, Philadelphia, Pa.
Earle Gear & Mach. Co., Philadelphia, Pa.

Gears, Cut—*Continued.*

Eberhardt Bros. Mach. Co., Newark, N. J.
Eickemeyer Mfg. Co, Yonkers, N. Y.
Fawcus Mch. Co., Pittsburg, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., The, Cleveland, O.
Massey Mach. Co., Watertown, N. Y.
Morse, Williams & Co, Phila., Pa.
New Process Raw Hide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Patterson, Gottfried & Hunter, Ltd., New York.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Wks., Cleveland, O.
Simonds Mfg. Co., Pittsburg, Pa.
Syracuse Raw Hide Mfg. Co., Syracuse, N. Y.
Taylor-Wilson Mfg. Co., Allegheny, Pa.
VanDorn & Dutton, Cleveland, O.
Walcott & Son, Geo. D., Jackson, Mich.

Gears, Molded

Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., Syracuse, N. Y.
Greenwald Co., I. & E., Cin., O.
Philadelphia Gear Wks., Philadelphia, Pa.
Taylor-Wilson Mfg. Co., Allegheny, Pa.
Walcott & Son, Geo. D., Jackson, Mich.

Gears, Rawhide

Boston Gear Wks., Boston, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Fawcus Mch. Co., Pittsburg Pa.
Gould & Eberhardt, Newark, N. J.
Horshburg & Scott Co., Cleveland, Ohio.
New Process Raw Hide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Syracuse Raw Hide Co., Syracuse, N. Y.

Gears, Worm

Albro-Clem Elevator Co., Philadelphia, Pa.
Boston Gear Wks., Boston, Mass.
Fawcus Mch. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Morse, Williams & Co, Phila., Pa.
Nuttall Co., R D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Simonds Mfg. Co., Pittsburg, Pa.
Taylor-Wilson Mfg. Co., Allegheny, Pa.
VanDorn & Dutton, Cleveland, O.
Walcott & Son, Geo. D., Jackson, Mich.

Generating Sets

Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Elec. Co., New York.
Stanley G. I. Electric Mfg. Co., Pittsfield, Mass.
Sturtevant Co., B. F., Boston, Mass.
Triumph Elec. Co., Cincinnati, O.
VanDorn & Dutton, Cleveland, Ohio.
Walcott & Son, Geo. D., Jackson, Mich.

Generators, Gas

American Gas Furnace Co., New York.

Gibs

Standard Gauge Steel Co., Beaver Falls, Pa.

Graphite

Dixon Crucible Co., Jos., Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Grinders, Automatic Knife

Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.

Files and File Testing.

BY EDWARD G. HERBERT.

What is universally adopted is usually wrong. If there be any tool, method, or process, which, sanctioned by the experience of generations has come down unaltered from a remote antiquity, it will usually be found that that tool, method, or process is wrong, or so far from perfect as to be in urgent need of improvement.

The application of this principle is not limited to the sphere of activity of the machinist or the tool maker, where it has received numberless illustrations within the last 15 or 20 years. But it does not fall within the scope of the present article to describe its wider application in the domain of politics, economics or religion. We must here confine ourselves to an examination of a single appliance, which appears to have escaped hitherto the notice of the reformer.

THE COMMON FILE.

The file is the commonest and one of the oldest of the tools employed by the modern craftsman. Its simplicity and its apparent efficiency seem to have defied any attempt at radical improvement. The advent of the file cutting machine has indeed revolutionized the process of its manufacture, but even here the aim has been to imitate as closely as possible the hand-made article, and the controversy still rages, at any rate in the ancient seat of the industry, between the advocates of the "hand-cut" and the "machine-cut."

I was led to investigate the properties of files through the difficulty, commonly experienced by file buyers, of deciding which of the many makers was able to give me the best value for my money.

A careful inquiry among file makers elicited the unanimous opinion that there is one make of files superior to all the rest. This was so far satisfactory, but when it came to the question *which* was the particular file enjoying this happy pre-eminence, unanimity was at an end. There were just as many "best files" as there were makers. From the buyer's point of view this was not particularly helpful, but on the side of the makers, it was undoubtedly a genuine opinion, based in many cases on actual experience. "We gave one of our men a file of our own make, and several of other makes, and let him file a piece of iron for a given time with each; on weighing the filings, our file was found to have taken off more than any of the others."

As the result of this investigation was inconclusive, it was resolved to make some tests from which the personal element should be entirely eliminated, and after some preliminary experiments, a special machine was designed and built for the express purpose of testing files.

A FILE TESTING MACHINE.

Of this machine it is sufficient to say that arrangements are made for reciprocating the file against the end of a specially prepared test bar planed to a section of 1 inch x 1 inch. The test bar is supported on rollers in a horizontal position, and is forced lengthwise against the file by means of a chain and weight, the pressure being removed on the back stroke of the file. A drum 8 inches long is driven from the machine and so geared as to make one revolution for 40,000 strokes of the file. A pencil is held by spring pressure against a sheet of section paper wrapped round the drum after the manner of the steam engine indicator, the pencil being so connected with the test bar, that it is moved parallel with the axis of the drum as the test bar is filed away.

The result is a diagram, in which vertical distances represent cubic inches of metal filed away, and horizontal distances the number of strokes made by the file. Several of these diagrams are here reproduced, and from the form of the curve, it is possible to learn all that need be known about the working properties of the file.

A large number of files have been tested on this machine, and, although the investigation is not by any means exhaustive, a number of interesting results have been obtained, some of which it is the purpose of this article to discuss.

INEQUALITIES BETWEEN OPPOSITE SIDES OF FILES.

Fig. 1 is a typical diagram taken from a 10-inch hand, middle cut file; pitch of teeth, 20 to the inch. (The length of the file does not affect the result as the stroke of the machine is not varied; in the case of a long file only a portion of its surface is tested.)

The two curves represent the two sides of this file, and a most striking and characteristic feature is the great difference between the two. Side *A* lasted 2¼ times as long, and did three times as much as side *B*.

This inequality between the two sides of the same file is one of the most remarkable facts brought to light by these tests, and it is of almost universal occurrence, being equally marked in hand-cut and machine-cut files. Of all those tested, only two gave absolutely coincident curves from the two sides, while the ratio between the total amount of work done by the two sides is usually more than two to one, and occasionally rises as high as thirty to one. An average of all the files tested gives a mean ratio of four to one between the work done by the good sides and bad sides, respectfully.

The result was quite unexpected and so surprising as to suggest the presence of some disturbing element in the testing process. Careful investigation has, however, failed to detect any extraneous cause. The files do not become sensibly heated during the test, so there can be no question of the temper being drawn; moreover, the better result is obtained as often as not from the second side tested, which would not be the case if any injury were done to the files in the process of testing. It appears, therefore, that the tests indicate an actual difference between the two sides of almost every file, and this receives confirmation from the experience of a friend, who states that during his apprenticeship he frequently found his files had a "good side" which he was accustomed to mark, and keep for special occasions.

Several possible explanations suggest themselves. The difference might be due to accidental variations in the cutting process, the sharpness of the tool, etc. This would only account for the variation supposing the tool to be so rapidly blunted as to require sharpening after each file, so that the second side was always cut with a blunter tool than the first. It might be due to some feature in the tempering process causing one side to be harder than the other. Again, it is possible that in cutting the first side, the blank becomes curved or buckled, so as to present a somewhat springy resistance to the cutting tool when the second side is operated on. Or it might be due to the teeth of the first side cut being in contact with the bed or block and so being injured, in the cutting of the second side. The question is one that can best be answered by the file maker. I have no practical experience of file making, and can offer only the above tentative suggestions, though it will be shown later that there are some special considerations pointing to the explanation last suggested.

It may fairly be claimed that the paradox at the head of the present article has received a further illustration.

RATE OF CUTTING.

Before resuming the detailed examination of Fig. 1, we may observe that the slope of the curve at any point is an exact index of the rapidity of cutting at the corresponding point in the life of the file. The rapidity or "rate of cutting" is expressed by the formula $R = \frac{I}{S}$ where I is the number of cubic inches filed away and S the number of strokes made in a given time. Thus—if r be the rate of cutting at any point P on the curve, $r = tan.\ \alpha$ where α is the angle included between the horizontal axis and the geometrical tangent to the curve at point P.

For convenience of comparison between different file diagrams, a function termed the "nominal rate of cutting" or "nominal rate" has been adopted. This quantity is found by drawing a tangent to the curve through the origin of co-ordinates. The

point N where this tangent intersects the vertical line marked 10,000 gives the nominal rate in cubic inches per 10,000 strokes. The nominal rates of the two sides of the file represented by Fig. 1 are 3.9 and 2.7, respectively. The nominal rate is a measure of the efficiency of a file before it has been damaged by wear, and is dependent on the pitch and shape of the file teeth.

The average rate of cutting is conveniently expressed in cubic inches per 10,000 strokes, and is found by dividing the total cubic inches filed away by the number of strokes required to wear out the file. The quotient multiplied by 10,000 is the average rate. It will be noticed that the average rate, which is indicated by the slope of the line OT corresponds less closely than the nominal rate with the actual slope of the curve and is therefore less useful as an index of the efficiency of the file.

PECULIAR BEHAVIOR OF FILES.

An inspection of Fig. 1 reveals one or two curious facts about the behavior of files. The first is that a file does not cut best when it is new, but when it has been in use a considerable time. Referring to curve A, it will be seen that this commences with a distinct upward curvature, and does not attain its steepest slope until 2,500 strokes have been made and about one cubic inch filed away. This characteristic, which is usually present though not always equally marked, will be referred to at a later stage.

Another striking feature is the abruptness with which the file ceases cutting. One might reasonably expect that a file would cut best when new, that it would begin to lose its sharpness almost from the first stroke and afterward deteriorate continuously and almost indefinitely. The diagrams show that the file actually increases its efficinecy during the first quarter of its life, and retains it almost unimpaired until it suddenly ceases to cut.

It should here be noted that the conditions under which a file is tested are slightly different to those which obtain in hand use. In machine filing, the pressure and the area of the filed surface, i. e., the pressure per square inch of the filed surface, remain constant. The file ceases to cut under that particular pressure, but it would be possible to get more work out of it under an increased pressure per square inch either by bearing more heavily on the same area, or by filing on a smaller surface with the same bearing pressure, and this would usually occur in hand filing. The purpose of the present tests was mainly comparative, and comparable results can be abtained only by testing under identical and unvarying conditions.

SOME COMPARATIVE TESTS.

Fig. 2 shows five superposed diagrams taken from files of the same size, shape and cut (10 inch hand bastard). It will be seen that No. 1 cut 3.7 times as fast, lasted 9 times as long, and did 34 times as much work as No. 5. No. 1 is of the cheapest of three qualities supplied by a certain maker and is the best bastard file which has been tested at the time of writing. The two more expensive qualities were greatly inferior. No. 4 is the "bad side" of the same file.

It may be remarked in passing that these results which are by no means exceptional, throw a somewhat lurid light on the present state of the ancient art of file making.

Fig. 3 illustrates the influence of coarseness of cut on the rate of cutting and durability of files. No. 6 is a middle cut, 20 teeth per inch; No. 7 a bastard, 24 teeth per inch, and No. 8 a second cut, 34 teeth per inch. These three files are by the same maker. Nos. 9 and 10 are smooth files, 44 and 42 teeth per inch respectively, by two different makers. It will be noticed that No. 10 did not cut at all under the standard pressure of 30 lbs. per square inch. To avoid confusing the illustration, only the good side of each of these files is shown.

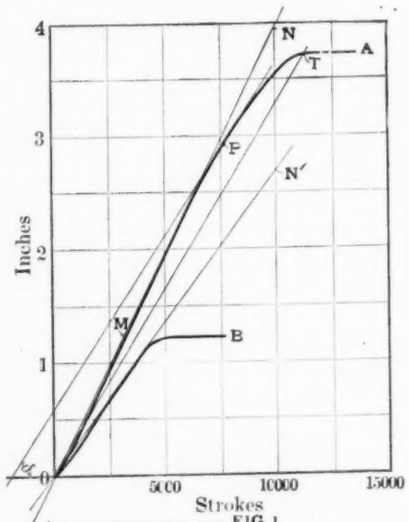


FIG. 1

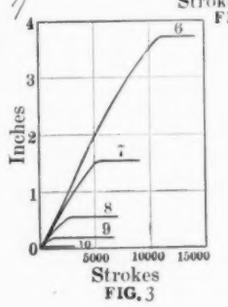


FIG. 3

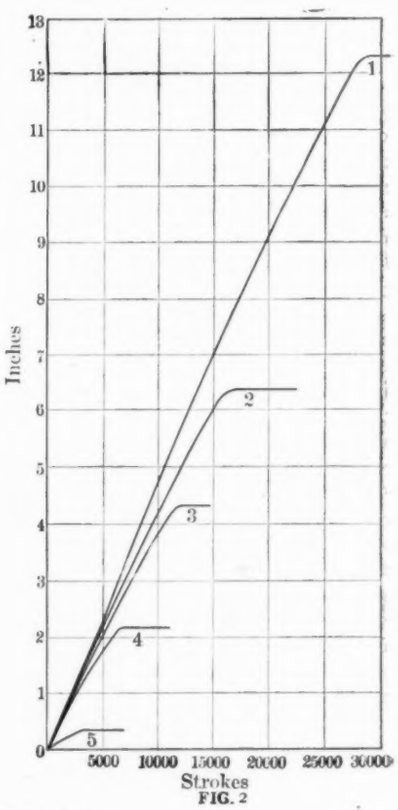


FIG. 2

DIAGRAMS OF FILE TESTS.

CUTTING QUALITIES AND ENDURANCE OF COARSE FILES AS COMPARED WITH FINE.

Two inferences are to be drawn from the diagrams in Fig. 3.

(1) A coarse file (other things equal) cuts faster than a finer one.

(2) A coarse file (other things equal) lasts longer than a finer one.

A large number of files of these four degrees of coarseness have been tested with similar results.

The relatively fast cutting of a coarse file is a matter of common experience, but the reason for its greater durability is not apparent at first sight. Take the two files Nos. 6 and 8, Fig. 3, made of the same steel, by the same maker, equally sharp, but the one having 20 teeth per inch, and the other 34 teeth per inch. Why should the larger number of teeth in the fine file No. 8 be worn out and cease to cut after 3,000 strokes, while the smaller number of teeth in the coarse file No. 6 took four times as many strokes and removed 6½ times as much metal before being reduced to the same condition?

A closer examination of the process of filing may throw some light on this question and on several other points raised by the test.

FILE TOOTH ACTION.

Consider the case of a bastard file having teeth pitched 25 to the inch, operating on a surface one inch square under a total pressure of 30 lbs., which is about what would be put on it in heavy filing by hand. The portion of the file which is in contact with the work at a given instant, consists of 25 cutting or scraping edges, placed one behind another, each edge being one inch long. As a matter of fact the edges are broken up into teeth by the light cross cuts, and this somewhat shortens their effective length, but ignoring this for the moment the file is analogous to a broad cutting planer tool, having an edge 25 inches wide, and pressed against the work with a force of 40 pounds, or rather more than one pound per inch of cutting edge.

In planing with a broad cutting tool it is

a common experience that unless the edge be extremely sharp, the tool will under a moderate amount of pressure, simply slide over the surface of the work without cutting it. If the pressure is gradually increased by feeding down the tool box, a point is eventually reached when the tool suddenly penetrates the surface, and probably takes off a considerable cut. The amount of pressure required to produce this result depends on the width and on the bluntness (thickness) of the cutting edge, being less for a narrow or sharp tool, and greater for a wide or blunt; in other words it depends on the area of contact (width×thickness) of the cutting edge with the work, and there is a definite pressure per square inch of edge contact, below which no rupture of the surface can take place. The amount of this limiting pressure is of course affected by the hardness of the planed surface and also by its smoothness, both of which we here assume to be constant.

In the case of a file, regarded as a broad cutting tool, the available pressure is so small, and the width of the cutting edge so great, that extreme sharpness is necessary in order that the limiting pressure per square inch of edge contact may be exceeded.

SHAPE OF TOOTH.

Fig. 4 is an enlarged view of the profile of typical file teeth. The line *A* represents the surface of the uncut blank. *B* is the depression made by the cutting chisel, and the portion of metal which originally occupied this depression is forced up in the form of a burr which is shown shaded in the illustration. It is this burr, which does all the work of the file. The front face *C* usually slopes backwards, presenting a somewhat unfavorable cutting angle to the work, and its extreme tip is often curled over backwards to a marked extent.

When a new file is set to work, the curled edges of the burrs which do duty as teeth, come in contact with the work, and, as might be expected from their shapes, they do not give the best possible cutting effect.

Being very thin and fragile they are soon broken or worn away, leaving a more or less sharp cutting edge, and it is during this breaking off of the curled tips that the rate of cutting gradually increases to a maximum as pointed out above, and illustrated in Fig. 1.

Some makers now use a sand blast for the purpose of taking off the curled tips of the teeth. This produces a file which starts work with its maximum sharpness, but at the expense of a certain portion of its life. It is in fact equivalent to cutting away that portion of the life of the file which lies below the point *M*, Fig. 1. It is possible that the sand blasted tooth is sharper than a tooth whose tip has been broken off in filing, but this has not yet been established by experience. The subject of sand-blasted files is at present under investigation.

EFFECT OF INCREASED AREA OF EDGE CONTACT.

When the file has arrived at its state of maximum efficiency, it continues to cut at about the same rate during the greater part of its life, all the work being done by the fine tips of the burrs. As these become worn the area of edge contact increases until the limiting pressure per square inch of contact is approached. Owing to slight inequalities in the length and shape of the teeth, some of them cease to cut just before the limit is reached and these by slipping over the work, polish its surface, thus diminishing the grip of the remaining teeth and making the total cessation of cutting even more abrupt than the experience with the planer tool would lead us to expect. The slipping stage is thus very short, and is characterized by a sharp downward bend of the curve.

In the case of a fine cut file, the area of edge contact is relatively great to begin with, owing to the large number of teeth. The pressure per square inch of edge contact is therefore small, which accounts for the slow cutting of the fine files, and a very small amount of wear of the teeth is required to increase the area to the

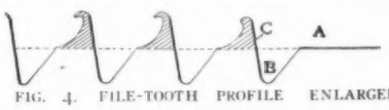


FIG. 4. FILE-TOOTH PROFILE ENLARGED.

limit, which accounts for the short life of the fine file. The actual amount of steel worn off the teeth is in any case extremely small and in the case of a smooth file which has ceased to cut, nothing more than a slight rounding and polishing of the tips of the teeth is apparent under the microscope.

SUGGESTED EXPLANATION OF INEQUALITIES IN OPPOSITE FACES OF FILES.

The extreme delicacy of the actual cutting edges of the file suggests an explanation of the peculiarity so clearly brought out in the diagrams, that one side of the file is almost always more efficient than the other. When the file blank has been cut on one side it is turned over and rested on the delicate burrs which have been raised, which are of course quite soft and whose tips are so fine that they might be turned with the finger nail. It is scarcely possible that the violent hammering to which the file is subjected in cutting the second side, should fail to injure these fine cutting points, even though the block on which they rest is no harder than lead. It is difficult to see how this injury can be avoided unless by coating the first side cut with a layer of some plastic substance such as pitch which would offer sufficient resistance to the blows of the cutting tool, while keeping the teeth out of the contact with the solid support. The files of one particular maker show so little variation between the efficiencies of the two sides as to suggest that the injury has been realized, and fairly adequate means taken to obviate it. At any rate this is a problem to which file makers should give their attention, as the present method of manufacture has the effect of reducing the possible working capacity of the files by 37½ per cent. on an average.

It should be noted that the above explanation is merely offered as a suggestion, and must not be taken as having been proved correct. Indeed there are some facts for which it quite fails to account. For instance it is observable that the bad side of a file often commences cutting at the same rate as the good side, but falls off rapidly at an early stage. This would seem to point to a difference in the hardness or durability of the teeth rather than in their sharpness. Again, it is not usually possible, by a microscopic examination of a new file to predict which will prove to be its good and which its bad side. Any flattening or deformation of the teeth sufficient to cause so marked a variation should surely be visible to the eye. I merely claim here to have proved the existence and the importance of the variation. The cause must be sought by a detailed examination of the manufacturing process.

VALUE OF THE FILE TESTER.

The file testing machine has amply justified its existence by the light it has thrown on the general behavior of files, and it has accomplished the main purpose for which it was designed, by showing the respective merits of the various makes now on the market. It has revealed in a startling manner the enormous difference which exists between files identical in size, shape, cut, appearance and price. And it is scarcely necessary to enlarge on the importance to the file buyers of an absolute standard of comparison. If file No. 5, Fig. 2, was worth the 10 cents that was paid for it, then, obviously file No. 1 was worth $3.40, merely on the score of the work it accomplished. In reality this represents but a small part of the difference in value. File No. 1 cut continuously for 11 hours, during which time it removed metal 3.7 times as fast as No. 5. Assuming the man using the file to be rated at 25 cents per hour for wages and establishment charges, the saving on these items effected by file No. 1 during its lifetime of 11 hours would be $7.45 as compared with the 34 files similar to No. 5 which would be required to do the same amount of work, and which would take over 40 hours about it. If one 10-inch file can effect a saving of $10 as compared with its equivalent in files of poor quality, how does file quality affect a firm using thousands of files a year? From the file users' point of view nothing further need be said, except that high prices and big reputations have not always been found synonymous with good quality.

It remains to be considered whether the special testing machine may not be made the means of effecting improvement in the manufacture of files.

FACTORS GOVERNING FILE EFFICIENCY.

The main factors governing file efficiency are three—the quality of the steel, the form of the teeth, and the temper. As long as file contracts are decided as at present mainly on the question of prices, so long will the business go to the makers using the cheapest steel that will harden. But once let value be substituted for prices as the ruling consideration and it will at once become possible for makers to employ the high class steels which have revolutionized engineering practice within the last few years. The use of expensive steel is under existing circumstances scarcely possible commercially. "A file is a file" and the maker who asked double the market price on the ground that his files had three times the ordinary life would meet with a good deal of scepticism. If he claimed that his files would do twenty, thirty, fifty times as much work as the ordinary quality, he would certainly be branded as an impostor, yet such differences are common among files now on the market, and it is reasonable to expect them to be greatly increased when files are made of the finest steel procurable, and hardened by scientific methods.

As to the second great factor in file efficiency, the form of the teeth, enough has been said to indicate one direction in which improvement may be effected. We must not continue to spoil one side of our files in cutting the other side. To remedy this should not be difficult, but it may fairly be asked whether the accepted method of file cutting is not even more wrong in principle than it is defective in practice. A bit of steel with some burrs raised on it with a chisel might well be considered a fine tool by our savage ancestors, but is it really the last word of the twentieth century tool maker? There is no tool used by the machinist in which perfection of the cutting edge is of such supreme importance as in the case of the file.—an edge several feet in width, with nothing but the strength of an arm behind it. There is no tool except the file in which such a travesty of a cutting edge would be tolerated,—a jagged burr sloping backward at an absurd angle and often curled right over. It is wonderful that such a tool can cut at all. It will be only less wonderful if the means of accurately measuring and comparing its efficiency does not lead to a development which will bring the file into line with the milling cutter and the twist drill, so much more limited in their application, so much later in their origin, and so infinitely superior in their construction.

Manchester, Eng.

To those Americans who are accustomed to the use of anthracite coal the introduction to a description of a new stove for burning it which we find in *The Engineer*, of London, will seem rather queer. It runs as follows: "Anthracite nuts as fuel for domestic purposes have hitherto met with little success, especially when used with an open grate. The difficulty of lighting, the intense heat when once set properly burning and the nuisance caused by the sulphur that is given off, have all been against its general adoption. Indeed we believe that it has only been used when no other kind of fuel was available."

Design for Sliding Head for Upright Drill.

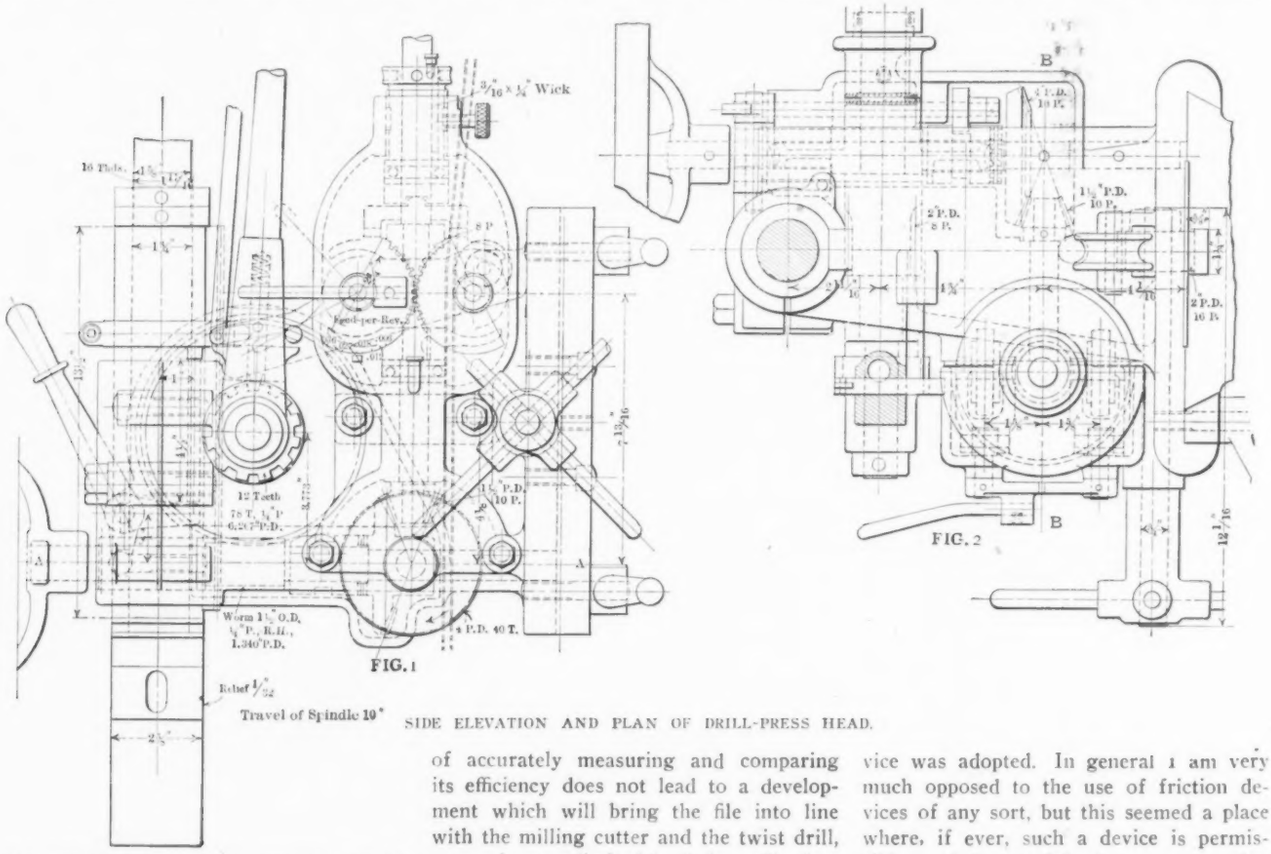
BY H. F. NOYES.

The novel features in this design are found in the power feed and the automatic stop.

Fig. 1 is a side elevation of the head, Fig. 2 a plan view, Fig. 3 a sectional plan taken on line *AA*, Fig. 1. Fig. 4 is a partial front elevation, and Fig. 5 a vertical cross section on line *BB*, Fig. 2. This head was designed for a 23-inch upright drill.

In deciding upon a form of speed variator for the power feed, a friction device was adopted. In general I am very much opposed to the use of friction devices of any sort, but this seemed a place where, if ever, such a device is permissible, and it certainly is yet a question whether for the smaller types of drills, the advantages of frictional feeds do not outweigh those common to positive feeds. In this case the friction precedes a big speed reduction; it makes an instantaneous speed variator which can be changed while running and while *under load*, and without shock; it gives a wide range of feeds from 0.006 inch to 0.036 inch per revolution of spindle; and it is sufficiently compact to be incorporated in the head itself.

The advantage of being able to instantly change the feed while under load and to any desired degree within its limits seems to me to outweigh the theoretical disadvantages of possible loss of power. And the device here shown is not experimental; the design has been used on a standard make of machinery for a good many years, and as long as a little care is used in



SIDE ELEVATION AND PLAN OF DRILL-PRESS HEAD.

keeping the disks free from oil, it never fails to pull.

The features of construction of this device are best described from Figs. 1 and 5. The usual splined feed shaft is provided, this being fitted to the upper friction disk very freely. The disk is driven through two two-toothed clutches, the teeth of one being at right angles to those of the other, and the upper one being keyed to the shaft, thus forming a universal connection for the upper disk and allowing the latter enough freedom to provide against inequalities of wear and fitting.

Interposed between the upper and lower disks are two friction rollers of rawhide, held between two rings of metal which are carried by yokes that are pivoted to two studs in order to provide for wear of the rollers. Ball thrust bearings are provided above and below the disks to take up the end thrust, and the pressure between the disks and rollers can be easily regulated by means of the upper adjusting nut.

To control the intermediate rollers, their studs are fastened to two intermeshing segments, one of which has an operating handle; and it will be readily seen that turning these segments in one direction or the other changes the diameters of the contact circle of the rollers with the upper and lower disks and thus varies the speed. One of the segments is graduated for feeds of 0.006, 0.012, 0.018, 0.027 and 0.036-inch and intermediate feeds may readily be interpolated if desired.

The flexible connection of the upper disk makes it possible for it always to bear equally upon each of the intermediate rollers. The disks should be accurately ground to a true radius, and the intermediate rollers should run on oilless bearings.

From the lower disk the drive is carried through two sets of bevel gears to the worm shaft and worm gear, as is better illustrated in Figs. 3 and 4.

In arranging for the automatic stop, it was desired to obtain a construction in which the release would not be affected by the pressure of the drill spindle, due to load, upon the worm gear and worm; and to that end a toothed clutch was introduced on the worm shaft, splined to that shaft, and adapted to engage the last bevel gear which runs loose upon the worm shaft.

To operate this clutch a stop ring fastened to the drill spindle, is provided with a projection adapted to engage a plunger which in turn operates through a bell crank, a horizontal plunger which carries a roller engaging the clutch. A handle is also connected with the bell crank affording an easy means of operating the clutch by hand.

The worm gear runs loose upon the pinion shaft and is provided with clutch teeth to engage a clutch splined to that shaft, which clutch can be readily thrown out of engagement with the worm gear when it is desired to use the hand lever or for quick return.

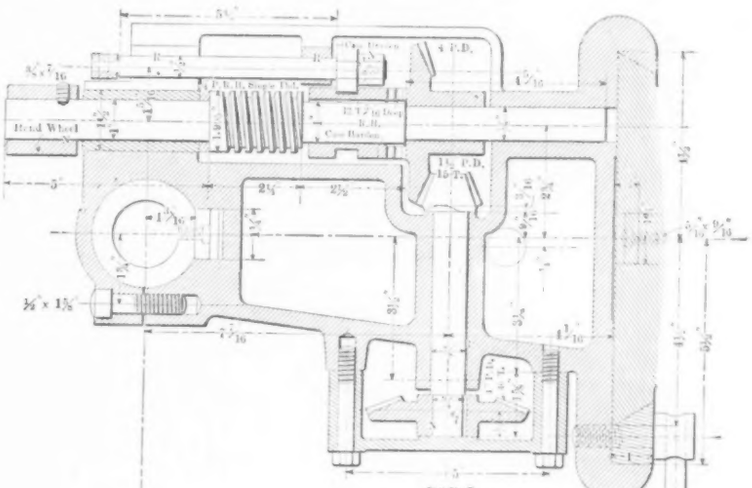


FIG. 3

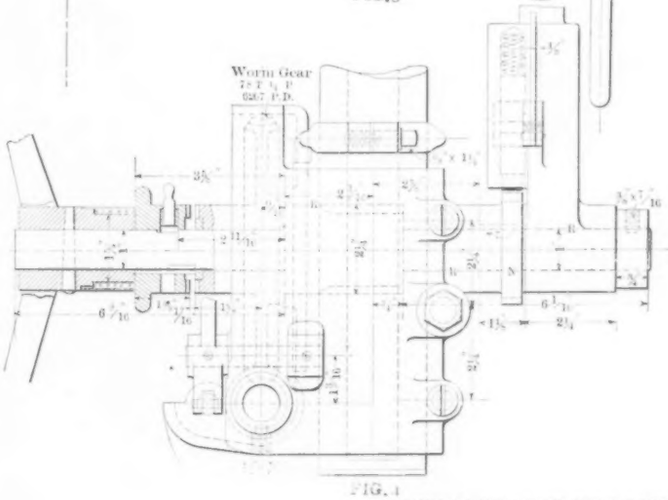


FIG. 4

SECTIONS THROUGH DRILL-PRESS HEAD.

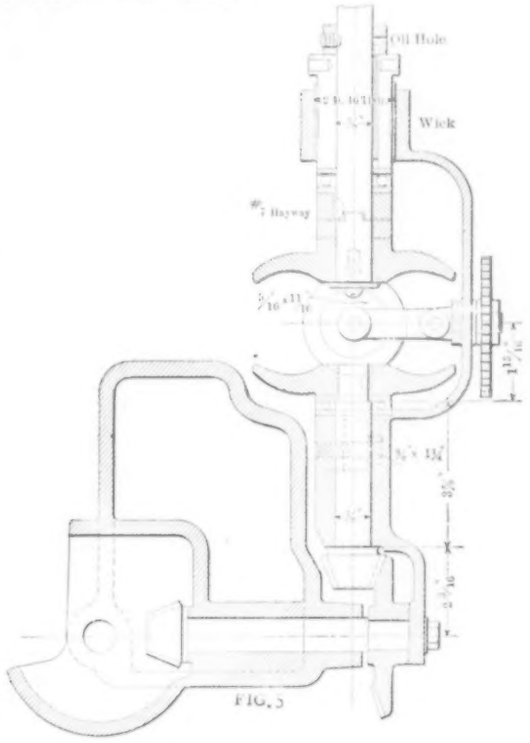


FIG. 5

It is possible that Sweden may be the first country in which electricity will generally displace steam motive power on railroads, as that country is rich in water power, but not in fuel. Alternating current, single-phase, has a strong chance of being the system adopted, as two experimental locomotives of this type have been ordered. One of them, which is being built by the Siemens-Schuckert Works in Berlin, and intended for freight service, will weigh 36 tons, have a maximum speed of 28 miles an hour and a maximum tractive effort of 13,200 pounds. The potential on the contact line has not yet been determined, but experiments will be made to determine what is the highest which it is practicible to use, the transformer on the locomotive being arranged to use a potential on the primary side of from 5,000 to 20,000 volts, the variation of the e. m. f. on the secondary (which gives the speed control) being from 160 to 320 volts. It is contemplated to use two aluminum bows for taking off the current.

Manufacturing Steam Pistons.

BY J. M. MENEGUS.

There was a time when the turning and fitting of steam pistons was considered a particular job, requiring the skill of a first-class mechanic. The great development of the steam-engine industry that made possible the making of steam pistons, etc., by the hundreds at a time, called for a method of manufacturing that would reduce cost, eliminate the difficulties and insure perfect workmanship.

Fig. 1 shows a piston as made by steam-pump manufacturers that consists of three parts—the body, the follower and the ring. They are from 6 to 20 inches in diameter, larger pistons being made of the box type with segmental rings. The turning of the ring was considered the most difficult part of the piston. It was made from a ring barrel and care had to be taken that it did not spring and that the two faces were parallel. To-day the rings are machine molded from metal patterns—as is also the body and follower—and are cast 3/16 of an inch wider than the finished size which is 2¼ inches for 20-inch pistons.

The uniformity of the castings made possible the use of the devices illustrated by the accompanying sketches.

The boring of the body *A* is done on a Gisholt lathe. The hole is first drilled and then rough-reamed with a taper reamer as shown by Fig. 2, guided by a bushing fitted on the chuck, and finished by a fluted finishing reamer of the same type. The body is then roughed down at *a*, faced at *bb* and *c*, and turned for the follower at *d* on an ordinary lathe, using the taper mandrel illustrated by Fig. 5. Several mandrels are made for the different bores of tool steel, tempered and ground, and all fit the gray-iron piece *A*, that is bolted on the face-plate of the lathe.

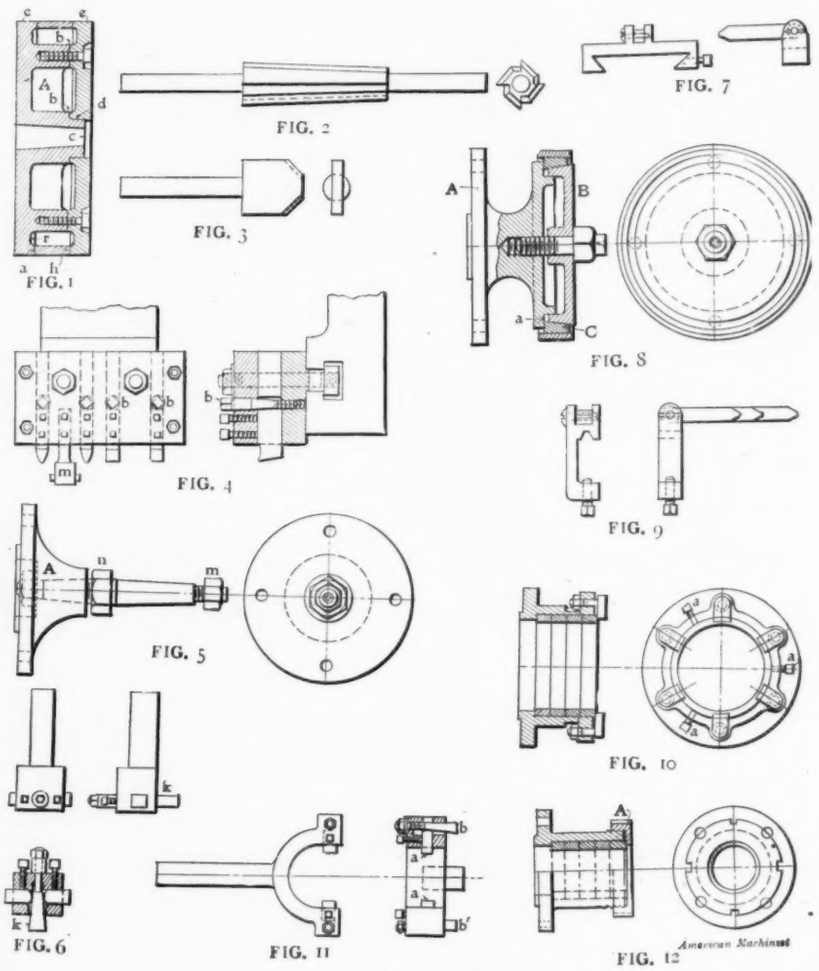
Face *c* is finished and the nut *m* tightened. Nut *n* is to release the body from the mandrel.

A carriage stop, as shown by Fig. 9, insures the right distance between the faces *a*, *b* and *c*. The follower is bored in one cut, using the tool shown by Fig. 3, and then faced. The bodies and followers are then drilled, tapped and bolted together after the faces *b b* have been scraped. The rings, from 14 inches up, are chucked and faced within 1/16 inch of the finished sizes. They are then bored, four or more at a time, using the rig illustrated by Fig. 10, on a cylinder boring machine, using two boring heads, one for roughing and one for finishing, the finishing cut being taken with ½-inch feed.

The rig is made of gray iron bored the same size as the rough rings, which are all of uniform diameter. The rings are clamped down by means of six screw clamps, as shown, and are centered, if necessary, by means of screws *a a*, three for each ring. The rings are turned on the outside on the expansion mandrel illustrated by Fig. 8. It consists of a body, *A*, that fits on the face-plate of the lathe, faced at *a* and turned for the taper piece *B*. *C* is a split taper ring, finished all over. When the central pin is screwed into the body *A*, the ring *C* expands.

The ring is turned on the outside using the tool-holder shown by Fig. 4, and faced using the tool-holder illustrated by Fig. 11. This is of forged iron, slotted for the tools *a a*.

Taper pins *b b* are used to set the tools to gage. The tool-holder, Fig. 4, is made



TOOLS AND FIXTURES USED IN MAKING PISTONS.

in two pieces, bolted together and slotted for four tools and for the tool-holder *m*.

The four tools are made with care, the same length, rounded at one end; two are for roughing and two for finishing and are set to turn the right diameter by means of taper pins *b b*. The outside of the pistons are thus roughed and then finished at *c c*, at one time, on the mandrel, Fig. 5.

The faces *a* and *h* are finished by using the tool-holder illustrated by Fig. 6—similar in construction to the one illustrated by Fig. 11—the taper pin *k* being used to set the two tools to gage.

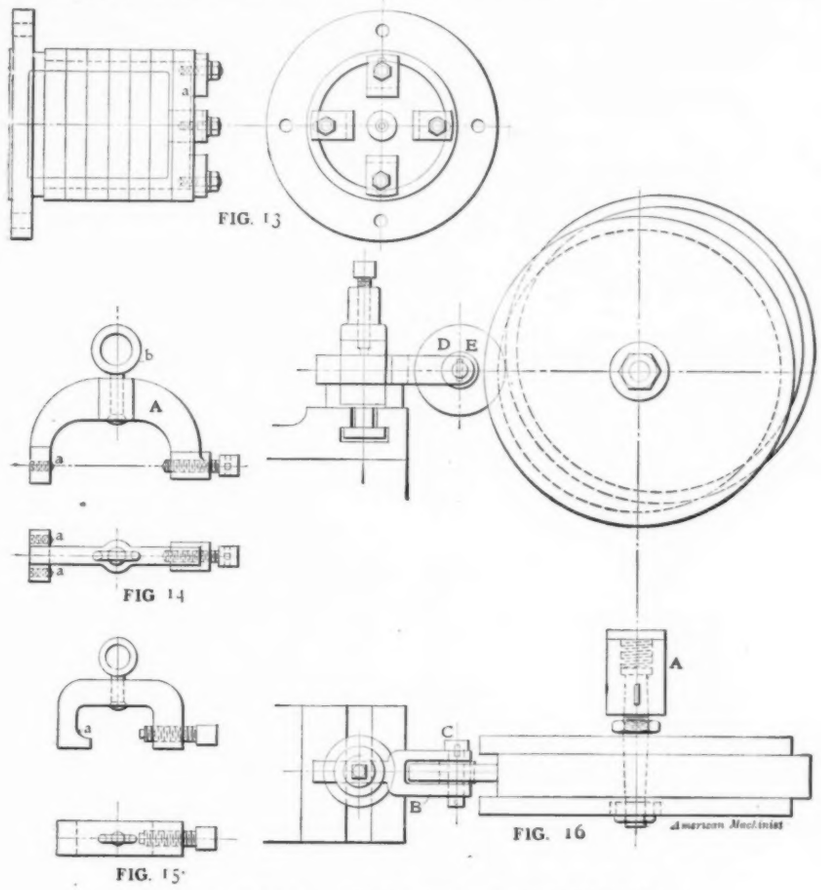
When the tools are set for one piston, they can be used for a number of pistons until dull. They are made to turn the right diameter by the use of the cross-slide stop shown at Fig. 7. Piston rings of 12 inches diameter or smaller are faced to the right thickness before any other operation is performed on them, on a mandrel similar to the one shown at Fig. 8, with the taper ring *c* turned on the outside, to suit the taper of the pattern. Rings of 8 inches diameter or smaller, are bored on a rig shown at Fig. 12, similar to the one illustrated by Fig. 10, only a screw collar *A* is used instead of the clamps.

Rings that are faced to the right thickness are turned on the outside, several at one time, as shown by Fig. 13. The rig consists of a gray-iron piece fitted on the face-plate of the lathe and turned the same diameter as the bore of the rings. The face *a* is below the outside face of the outer ring. The rings are clamped down by means of four straps, as shown.

The rings have then to be ground in their pistons. Fig. 16 shows how this is accomplished. Several taper mandrels having one end that fits the bores of a certain sized piston are made, the other end fitting the gray-iron piece *A* that is screwed on the spindle of an old lathe. The fork *B* is drilled for the case-hardened pin *C*. The gray-iron roller *D* has a

hardened steel bushing *E*. Oil and emery are put between the faces of the piston and of the ring, and the follower is bolted on. When the piston turns and the roller presses against the ring, the latter takes the position shown by the sketch. The ring is ground in until the follower is tightly bolted on the body, when the ring will move if tapped lightly with a hammer.

Fig. 14 shows a clamp to hoist the large pistons on the machine when they are fitted together. The forged iron piece *A* has three hardened steel screws *a a*, riveted on, and an eye-bolt *b*, which hooks on to the lower block of the hoist.



TOOLS AND FIXTURES USED IN MAKING PISTONS.

Fig. 15 shows a clamp to hoist the body, the toe *a* fitting in the recess in Fig. 1.

Using these rigs, pistons can be manufactured in remarkably short time, 20-inch pistons and rings, including grinding —except the machining and fitting of the tongue and spring—can be finished in an average of from three to four hours each.

Owing to the failure of Congress to include in the Urgent Deficiency bill an appropriation of a million dollars asked for to cover the cost of repairs on certain ships of the Navy, Secretary Bonaparte on January 23 issued an order reducing by 44 per cent. the force of employees in the Bureau of Steam Engineering, working at various yards and naval stations. About 1,000 men were dismissed.

Charles Brown.

Engineering in its edition of December 29th, published a remarkably interesting article under the above title, and as many of our readers here in America have visited and been interested in the various engineering establishments of Switzerland with which Charles Brown had so much to do, we abstract from the article, which besides being a just tribute to a remarkable man shows how much it is possible for one country to gain and another to lose by the emigration of a citizen. Following is the abstract:

A few weeks ago we recorded briefly the death, on October 6, of Mr. Charles Brown, the record of whose life constitutes a most important chapter of the development of manufacturing engineering on the Continent, and particnlarly in Switzerland. Charles Brown was born on July 30, 1827, at Uxbridge, near London. A few years later his family moved to Woolwich, which at that time, as now, was the principal arsenal of the country.

Charles Brown had a bright and cheerful disposition, and early gave proofs of a large share of common-sense and capability. He had an instinctive liking for books and publications; a predeliction which he maintained to the last days of his life. Notwithstanding the little encouragement he received from his family, he managed to make the acquaintance of Mr. John Anderson, general engineer manager of the Woolwich Arsenal, and later on that of Professors Barlow and Davis, of the French Professor, and of Mr. James March, chief chemist in the Arsenal Laboratory. On the advice and with the help of these gentlemen, the youth took the opportunity that was offered him of learning the principles of science in theory and practice, and this led him to decide upon spending a few years in the shops of some engineering works. But a great difficulty arose in carrying out this plan, seeing that in these early days it was necessary to sign a seven years' agreement, and during the working hours it was not possible to leave the shops in order to attend any technical courses. With a view, therefore, to increase his practical knowledge of mechanics, the youth put down a small plant of his own, with lathe and boring machine, and started manufacturing models, small engines, and apparatus for physical tests, and solved many a small problem for his patrons above-named. Notwithstanding the difficulties which at that period stood in the way of ambitious youths, Charles Brown succeeded by his own exertions, his indefatigable activity, and absolute will-power, in perfecting himself so as to be able in his nineteenth year—in 1846—to commence his active life. Through the influence of Faraday, he was then taken on in the works of Messrs. Maudslay, Sons & Field, where he worked with Mitchell—who later on was a partner in the firm of Armstrong, Mitchell & Co., of Newcastle—and with C. Walker, both of whom also made names in the engineering world. Charles Brown remained with Messrs. Maudslay until 1851, first under Lambert; later on he was allowed to work under the late Charles Sells, the capable engine-builder, who had the direction of the works. He has often stated that he owed a great deal to the latter; he frequently added also that Sells was the most conscientious, the hardest-working, and the most clear-headed man he ever met in the whole course of his life.

At Maudslay's Charles Brown laid the foundation for his future achievements; and after a very short time his abilities were so highly thought of that in 1851 he was asked by Messrs. Sulzer Brothers, of Winterthur, to enter their service. This firm then owned but a small works, consisting mainly of a foundry, a boiler-shop, and a small repairing-shop, the latter equipped with a couple of lathes, boring-machines, etc., giving occupation to about seventy men. The task placed before the young Englishman was the reconstruction of the works and the starting of manufacturing operations on modern lines; a task which, when he first contemplated it on the actual spot, appeared in its magnitude almost impossible to achieve, and he longed to be back again in the London fog.. He was not long, however, in mastering his first feelings of des-

pondency; his principals placed the necessary financial means at his disposal for putting down plant and developing the new works; and, after twenty years of activity, Brown had raised the number of men employed to 1700. (We may mention here in passing that they number 5000 at the present day.) The small factory, in his able hands, was soon modernized and improved, the machine-tools were replaced by new ones, and the Sulzer Works were in a very short time reputed to be among the best equipped in Europe. While at these works Charles Brown designed and introduced the well-known Sulzer valve-gear, which has been most extensively copied, its merits being universally recognized, while it has also given rise to very numerous other gears allied to it in principle. Engines of the Sulzer type have long enjoyed a reputation for exceptional steam economy, and, as years have gone by, have more and more established a predominating position on the Continent. At the Paris Exhibitions of 1867, 1889, and 1900, the engines with this gear obtained the highest awards. It may be noted that the valves, being of the drop type, are peculiarly adapted for use with superheated steam. In 1871 Charles Brown severed his connection with the Sulzer Works, and laid the foundation of the Swiss Locomotive Works, of Winterthur. Here he developed a modification of his previous valve-gear, which is identified with his name. The success which Brown met in locomotive construction, especially in regard to locomotives for mountain traffic, was so rapid that his engines won the highest awards at the Paris Exhibition of 1878. In the same way as he brought the stationary engine to the highest possible degree of efficiency and beauty, so in locomotive construction he obtained such admirable results that, notwithstanding the comparatively unsatisfactory situation of Switzerland as an industrial country, his types found application throughout the whole world.

In the early eighties Charles Brown, whose tastes were always those of the pioneer, had become tired of locomotive construction; he longed for a different class of work, and selected electricity; and in the same way as he had introduced on the Continent the manufacture of high-class engines and locomotives, he also had a prominent part in creating the Swiss electrical industry. As early as 1884 he founded the electric department of the Oerlikon Works, and thanks to his knowledge and experience, his electric machines also constituted a new departure in construction. In 1891 Mr. C. E. L. Brown and his brother, Sydney Brown, founded the now famous works of Brown, Boveri & Co.; and were later on induced by their father to add to their electrical manufactures that of the Parsons steam turbine. With regard to this, we may mention that at the Paris Exhibition of 1889, Charles Brown, Sen., took the opportunity of the exhibit made of a turbo-generator to express to a small group of engineers who surrounded him the opinion that the turbine would supersede the piston engine; and he prophesied that in the twentieth century rotary mechanisms would rule to the same extent as the reciporating motions ruled in the nineteenth. On other occasions, he frequently took the opportunity of laying great stress on the immense importance of Parsons' discovery, and made many attempts to induce Continental manufacturers to take up the manufacture of the turbine; but was unsuccessful until, as above stated, his sons yielded to his persuasions.

When new ideas were brought forward, showing advantages over established practice, Charles Brown would "scrap" the old without mercy, even although some of his own best works were involved in the sacrifice. He had much artistic feeling, and aimed at giving a graceful design to his productions, whilst maintaining intact all their efficiency for the purposes for which they were designed. When he had solved a mechanical or manufacturing problem, however, he lost interest in it, though at any moment ready to destroy his own solution if a better offered or occurred to him. He had little instinct for business, his enjoyment being found in the exercise of his exceptional talent for invention, rather than in securing great pecuniary advantages from the products of his brain. He had an extraordinarily wide and accurate knowledge of all departments of technology, and was in constant correspondence with the leading engineers in Europe and America, who were glad to consult him in all mechanical difficulties. Up to the very day before his death he was actively engaged in his favorite pursuit.

In his fifty-eighth year Charles Brown was offered the general direction of the Armstrong works at Pozzuoli, near Naples, then in course of organization; he could, however, settle down in this sphere of action, and find in it scope for his activity, for but a short number of years; and he soon afterwards returned to Basle, where he continued his practice as consulting engineer. His sketch-books, which have been preserved, afford ample proof of his activity and originality in all branches of technology. In addition to his great creative faculties, Charles Brown also possessed to an extraordinary degree the talent of communicating his knowledge to third parties. Numerous are the engineers scattered through every land who have been fortunate enough to gain knowledge from him. He was able to discover the capabilities of each, from the locksmith to the responsible engine-builder, and to develop these capabilities. In the same way as when he first went to Switzerland, many years ago, he quickly taught agricultural laborers to fashion iron and steel, so did he perfectly understand how to proceed in educating the rising generation of engineering pupils; and to him, in a very large measure, little Switzerland is indebted for the fact that her engineering works today enjoy such a high international reputation.

His instinct for grace of form, combined with his great practical knowledge, formed the main basis on which were built his successes. In all his designs, his principal maxim which he followed was this: "The great science of construction is to leave out pieces." A few years ago an eminent American engineer, after having taken a journey throughout Europe, stated that Brown's designs were like colored threads laid on the continent of Europe, pointing back to Switzerland, their place of origin, from which they radiated.

In order to show the high regard in which Charles Brown was held by those who knew him best, we may be allowed to give here the words spoken on the day the cremation took place—October 9—by Mr. Sulzer-Stenier, Sen.: "Charles Brown was an eminent, highly-talented constructor, who not only by his talent, but also by his excellent character and his pleasing manners, won all sympathies. He became in a short time a creative personality in the technical industry in Switzerland, and his influence was felt over our borders, in Germany and Italy. With his great talents were coupled a most complete assiduity, and it was granted him to continue his work up to his very last days without interruption: death found him at his work-table."

In a paper published in a recent issue of the *Physical Review*, A. P. Carman gives a description of some preliminary experiments on the resistance of tubes to collapse. The tubes tested were of brass, and ranged in mean diameter from 0.35 in. up to 0.72 in. The thickness of the tubing ranged between 0.016 in. and 0.053 in., while the range of lengths was from about half diameter long up to 170 diameters. In accordance with the usual theory, it was found that beyond a certain ratio of length to diameter, the resistance to collapse was independent of the length, though for lesser ratios than this the collapsing pressure, in agreement with Fairbairn's experiments, diminished as the length increased. The highest pressure reached in the experiments was about 850 atmospheres. Mr. Carman proposes to continue the research, as, owing to variations in the quality of the material tested, the data obtained were insufficient to permit of a proper comparison between calculation by theory and the actual experimental results.—*Engineering*

Etching fluid for marking tools. Mix one part of muriatic acid, one of nitric and four parts of water. The article is coated with wax. The design is scratched in.

Speed-Change Gears.

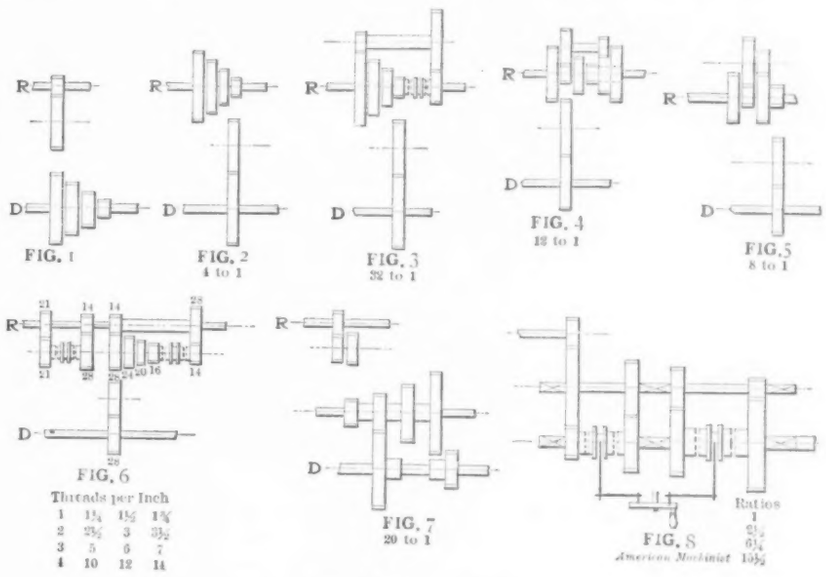
BY A. M. SOSA.

In a recent article at page 808, Vol. 28, Part 2, some very interesting examples of "Gear Box Drives" were given, and this suggested to me the idea of illustrating some similar examples of speed-change gearing, especially those that apply to feeds for machine tools.

Fig. 1 shows the most usual way of applying the cone-gear mechanism, in which *R* indicates the driving and *D* the driven shaft. This arrangement is most economical for drives, where the power transmitted is constant. The largest gear gives the slowest speed and maximum torque, the smallest *vice versa*, and the pressure on all gear teeth, as well as lineal velocity, is constant.

For a ratio 4 to 1, starting with a 14-tooth pinion, the largest would be a 56-tooth gear. This difference in diameter of gears is cumbersome and marks the limit as to the cone ratio. Next to the feed-gear box or in some other part of the machine we generally find a second box containing four gears and a clutch, which is called the "speed clutch box," and which forms part of the feed mechanism. This is nothing more than a back gear, and in many cases is used more for increasing the ratio of feeds, than for multiplying their number, for this could also be done by increasing the number of the cone gears.

It seems more economical, when possible, to place this back gear on the cone gear itself as shown in Fig. 3, in which the cone is in one piece and runs loose.



SPEED-CHANGE GEARS.

Fig. 2 is the inverse of Fig. 1. The cone is on the driving and the sliding pinion on the driven shaft, which may be connected to the feed screw, or it may be the feed screw itself. The sliding pinion is of the same diameter as the largest cone-gear, and gives the 1 to 1 ratio, which is the fastest, and requires the maximum torque.

Here we have low speeds, as one revolution of the screw gives a feed equal to its pitch, and very coarse pitches are most in use. The power is a maximum for the coarsest feed and is transmitted through two large gears instead of two small pinions. The large gear on the screw reduces the pressure on the gear teeth and permits the use of small pitches and gives a more compact arrangement.

At the same time an increase of lineal velocity on the gear teeth is the result, but this is a rather desirable feature when low speeds are concerned. The ratio of speeds obtained by this method is as the ratio of the diameter of the largest and smallest cone-gears.

The clutch slides, keyed on the shaft, and transmits the motion to the cone directly or through the back gear. With gears 4 to 1 in diameter, as shown, a ratio of feeds of 32 to 1 in round numbers is conveniently obtained.

If the back speed, due to the clutch being on the first shaft is to be eliminated, the back gears may be swung out of mesh. As will be noticed, two or three operating levers are necessary.

Fig. 4 shows a combination for six feeds, speed ratio 12 to 1, and gear ratio 3 to 1. This is operated by one lever, the tumbler lever only. If the running speeds are low, it does not seem to be an objection to have all the gears running. This cone is in two parts; the first three gears are keyed to shaft *R* and the other three run loose, are in one piece on the same shaft and receive motion through the back gear as shown. Compounding two cones in this manner, a very large ratio may be had, with relatively small gears.

Fig. 5 illustrates a cone of four gears with a diameter ratio of 2 to 1 only, giving a ratio for the cone of 8 to 1; the arrangement is the same as in Fig. 4. The difference may be noticed by comparing this with Fig. 2. The numbers of teeth of the gears are given in Fig. 6. The smallest pinion has 14 and the largest gear 28 teeth. The first two gears are keyed to shaft *R*, the other two running loose on a sleeve. The cone runs loose and is in one piece. Both clutches slide on keys on the cone shaft, and the other three gears run loose on the cone shaft. This arrangement seems very convenient for screw cutting. The table of threads per inch is shown in the figure. When the feeds per inch are arranged in successive groups, and each group is a multiple of the previous one, the gear ratios can be easily seen. The last group gives more directly the ratios of cone gears. The first number of first and second groups, gives the ratios for the clutch gears 1 to 1 —2 to 1. The first number of the third group (4), gives the back gear ratio 4 to 1. And the first number of the last group is the product of clutch gear (2) and back gear (4), and represents their combination.

Fig. 7 represents a type of drive with cone and sliding gears, similar to the one recently illustrated by H. T. Millar. The compounding of cones suggested for feed gears would not seem advisable for the reasons previously explained, but compounding the tumbler gear would not change the conditions materially, and double the number of speeds may be obtained. What is generally the idler is, in this case, made of two gears in one piece, running loose on the stud. The ratio of these gears is equal to the percentage of increase of the two next speeds, in this case about 1.2 to 1. The cone gears are spaced at a distance equal to the width of face plus clearance. The gears are drawn to scale, relative to each other, and represent a geometric progression of 16 speeds with a ratio of 20 to 1. The total number of gears used is only nine.

For heavy drives it is not possible to make combinations in the manner previously stated, and the back gears are more successfully grouped separately.

Fig. 8 shows a combination of four gears. The ratios may be scaled as 1, 2½, 6¼ and 15, to 1. Different considerations enter into this problem, such as the distribution and the alinement of bearings, the elimination of sleeves and running fits under pressure or torsion and reducing the number of clutches, operating levers and interlocking devices.

At the steel works of Samuel Osborn & Co., Sheffield, England, a large sum is being spent on the introduction of gas engines as the prime movers, in some cases in combination with electric generators. In one of the plants the gas for the engines is taken from the same producers that are employed for the Siemens furnaces.

Making Interchangeable Crossheads, Bodies And Slippers.

BY J. C. DUFRESNE.

All steam engine builders have their crosshead troubles and yet very few have attempted to eliminate these troubles by making the bodies and slippers interchangeable, although they make large numbers of crossheads of the same size.

Crossheads are generally developed as follows: The slippers are milled in a gang. Two are selected and filed to fit a body; they are then drilled and riveted to the body and turned with it on a mandrel. After drilling the rivet out the crosshead is assembled, care being taken to stamp slippers and body so that slippers can be put back on the same side where they were turned. This method in one shop at least is ancient history and the bodies and slippers are now made interchangeable and kept in stock separately.

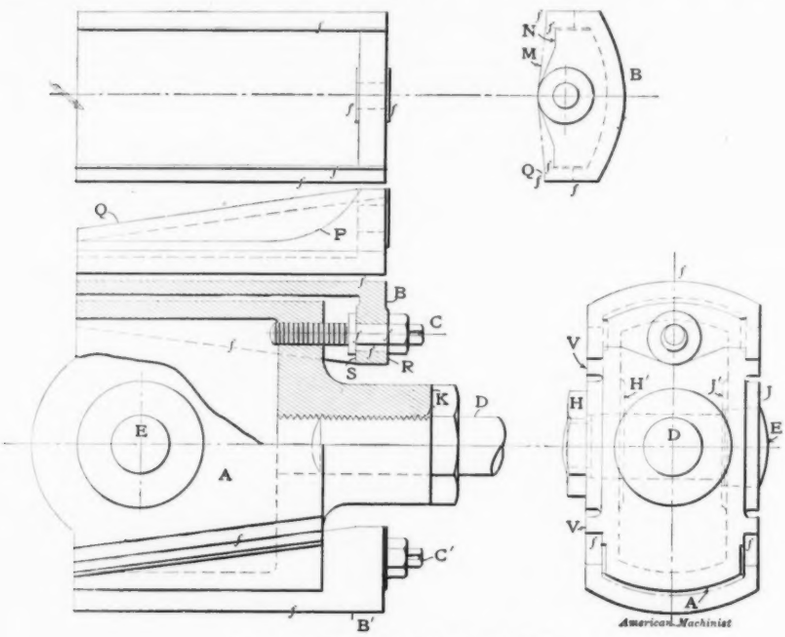


FIG. 1. CROSSHEAD AND SLIPPER.

Before making the fixtures we had to change the slipper and pin to cheapen them. The slipper was changed on the pattern from line M to N (see Fig. 1), to allow the milling cutters to go through the full length. The old way of milling is shown by line P. Formerly they were milled parallel to the turned face B, now they are milled parallel to the slide face Q. A slight change was also necessary on the pattern of the body to correspond to change made on slipper.

In Fig. 1 A is the body, B and B1 the slippers, C and C1 the screws which hold and adjust the slippers. D is the piston rod and E the wrist pin which goes in one end of the connecting rod. If hole D is not central and parallel with the turned faces on B and B1 the piston will bear on one side of the cylinder and the slipper on one side only of the guides.

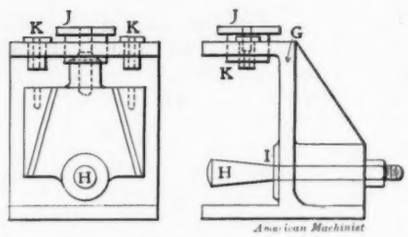


FIG. 2. DRILL-JIG FOR CROSSHEAD BODY.

If the taper ways are not correct the slippers will bear on one end only, the same thing will happen if the faces R and S are not at right angles to the turned face, or if C and C1 are not tapped correctly. The shoulders on the pin E come about 1-16 inch under faces H and J1 to allow for slight variations.

CROSSHEAD BODY OPERATIONS.

The first operation on the body is to bore the hole for wrist pin E. This is done on a Gisholt turret lathe, holding body with fixture shown at Fig. 7.

The four holes A are for securing the fixture to the face-plate. The projections B are for "heels" for one end of the straps X to rest on. C is a projection at the back to locate the fixture on the face-plate. D are three points for the crosshead body to rest upon; E three screws for locating the crosshead in place. F are two studs for clamping the straps X. The hole is rough bored with the boring bar A1 (see Fig. 8), which has two cutters of different diameters so as to leave as little stock as possible for the roughing reamer. It is then faced at H, H1, J and J1 with tool held in the tool post. The stops on the machine are used to give the correct spacing of the cheeks. There are two of these tools B, one for roughing and one for finishing. The hole is then rough reamed with C, which is a reamer with left hand spiral flutes and nicked teeth.

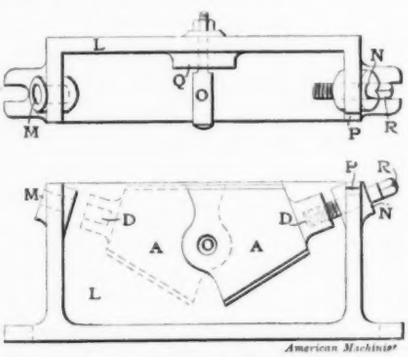


FIG. 3. MILLING FIXTURE FOR THE CROSSHEAD BODY.

This is followed by a finishing reamer. Stop collars D—made of soft steel—on each reamer give the proper depth.

The face H being established we work from it to completion of the body.

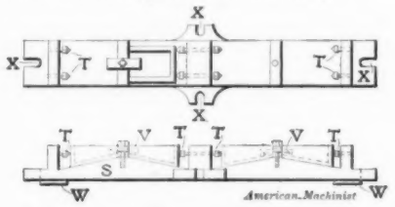


FIG. 4. MILLING FIXTURE FOR SLIPPERS.

The second operation is to drill and tap the holes for C, C1 and D and face at K, which are done with jig shown at Fig. 2. G is the jig body. H is the pin for drawing the crosshead into place against the faced projection I. The bushing J is threaded. Its bottom end is countersunk so as to center the crosshead when it is screwed down over it. The bushings K are for drilling for the slipper adjusting screw C and C1.

The third operation is to mill the ways L and L1, using jig, Fig. 3. In this jig the crosshead is mounted on the pin O and is swung over till the hole D coincides with either the hole N or M of the jig. The pin R is then passed through the hole N or M and screwed into the threaded hole D. The projection P is of tool steel hardened for setting the cutters to correct depth. The crosshead A is drawn up against the face Q and the cut started with the cutters shown in Fig. 5. One side is milled with the pin R in M and the other with it in N. The sharp corners are then filed off and the faces V polished.

OPERATIONS ON THE SLIPPERS.

The first operation on the slippers is to mill them as shown at Fig. 6. They are held four at one time in fixture, Fig. 4. S is the fixture body, having tongues W to fit the T slots in the milling machine table and holes X for the holding down bolts. The clamps V hold the slippers down and the conical headed set screws T hold them in position endways.

The second operation is drilling in the jig shown at Fig. 9. The cap A and base B are put on C, which is also the fixture

for turning. The body C is of gray iron. Inserted in the ends are two hardened steel centers D. The slippers are held in position by the set screws F and the clamps G. The bushings E guide the drills while drilling the holes in the slippers for the adjusting screws.

The final operation is to turn the slippers (see Fig. 10). The stud A fits the

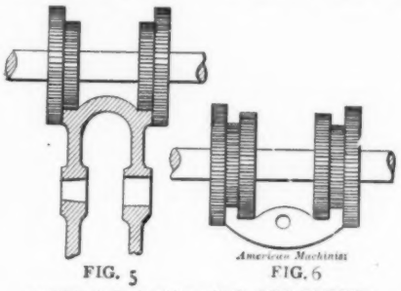


FIG. 5 FIG. 6

CUTTERS FOR THE BODY AND SLIPPER.

hole in the slipper. This holds one end of it. The other end is held by a hard tool steel toothed clamp B. The larger sizes have two of these clamps on each slipper.

Standard gages are used for crosshead and slippers throughout.

The Russian and Siberian Machinery Markets.

Too much importance should not be attached to the present disturbances in Russia. They very naturally tend to dislocate trade to some extent; but such things are in their nature but of transient importance. The Russian Empire possesses such vast economic resources that nothing can prevent their ultimate development. It has such an enormous area that hundreds of thousands of people in remote districts are probably unaware of the present riots in Moscow and other big centers. It was much the same in China after the war between that country and Japan. Millions even of Chinese be-

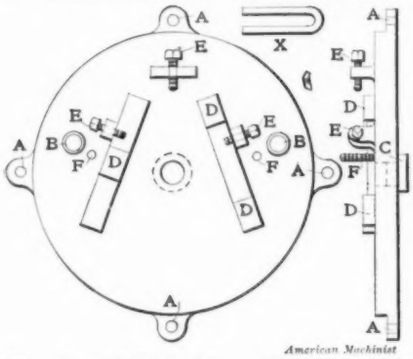


FIG. 7. FIXTURE FOR CROSSHEAD BODY WHILE BORING WRIST-PIN HOLE.

lieved that China had conquered, while large numbers of people there were practically ignorant that any war had taken place. Both the Russian and the Chinese empires are so vast and the means of communication in many districts so limited that news travels very slowly, if indeed it may be said to travel at all. Therefore, although there are political disturbances in the big Russian cities the vital industries of the country are still there, although demand may be temporarily delayed.

There is a very considerable market for machine tools in Russia and Moscow is a large purchasing center. At present the greater part are imported from Germany; but there is no reason whatever why the United States should not participate to a greater extent in this business. Your quality of steel is of the highest, but the Germans supply a cheaper style of tool than is usually turned out of an American factory. As a rule the Russian operative is rather uneducated and not what you would call a skilled workman; hence the class of goods required is of a somewhat stronger and rougher description than what would be used by a skilled American mechanic. The near future promises well for makers of textile machinery, especially in the Warsaw district of Poland and more spinning machinery

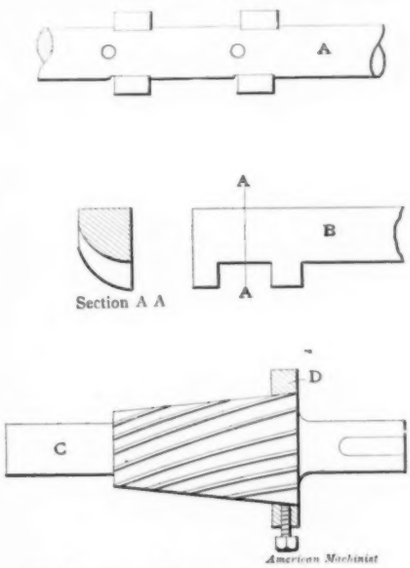


FIG. 8. TOOLS FOR THE CROSSHEAD BODY.

will have to be imported to cope with the demand for textile goods. There has already been a marked improvement in the import of weaving and finishing machinery, the bulk of which has hitherto been obtained from Germany and Austria. It may be mentioned, too, that German makers have been doing a fair trade during the last year or so in steam engines, gas and oil motors and similar machinery. The present duty on this class of machinery is about $3.40 per cwt., but it will be increased to about $5 per cwt. in March, when the new tariff comes into operation. For this reason many firms have ordered new engines with a view to future extensions or to replace others which have become out of date. The sale of motors for utilizing naphtha, petroleum, and benzine is progressing favorably. This kind of motor will probably be used more and more throughout the empire, and it seems a pity that American makers do not supply some of this machinery, which at present comes from Germany. The chief points to be considered by exporters when catering to the Russian market are these: Simplicity of construction; lightness; depots where all sorts of machinery can be shown and

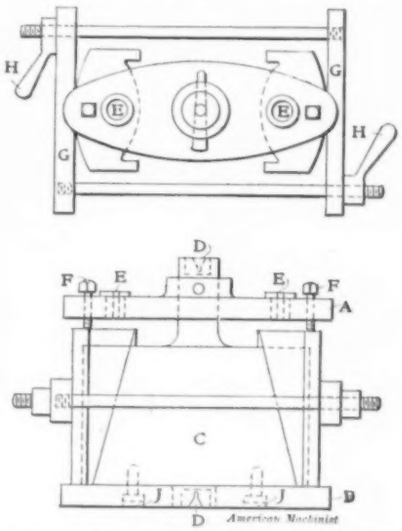


FIG. 9. FIXTURE FOR DRILLING THE SLIPPERS.

their construction, etc., explained in the local dialect to would-be purchasers; interchangeable parts and standardization of machinery; accuracy of manufacture; simplicity of arrangement; cheapness and easy terms of payment; careful packing. Although the present demand in Siberia for machinery—except agricultural machinery and farm implements—may not be very extensive, yet the sale of modern industrial equipment and mechanical appliances is certainly growing. I refer more especially to that part of Siberia west of lake Baikal. Foreign machinery is well represented in that country. The great railroad and the government works in connection with it, though under recommendation to order Russian-made ma-

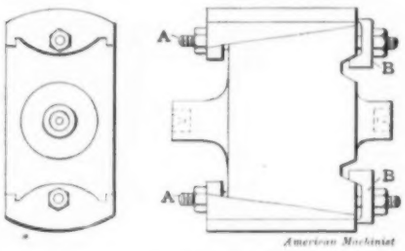


FIG. 10. FIXTURE FOR TURNING THE SLIPPERS.

chinery whenever possible, still offer considerable scope for foreign articles. It is well known that the recommendations above referred to have been and are still of limited application. Various machines, though nominally Russian, with or without the mark of Russian works, or with the foreign indication removed, are in reality of foreign make. In Siberia proper, Germany has the larger share of the general machinery market,

apart from agricultural, though it is rivaled by the United States and Great Britain in far eastern ports. The chief cause of German predominance would seem to be: Superior cheapness, which is an indispensable attribute in Siberia; lightness and general correspondence of goods with the requirements; easier facilities offered and especially easier credit terms. Among other points which the Germans have studied are the superior accessibility on the part of their manufacturers; greater pushing of their goods and willingness to accept business, however small, as well as to meet all possible suggestions and adaptations. The presence of German resident firms or business men, whether Germans proper or Russo-Germans, at the bigger centers, and periodical visits of representatives, and consequent closer knowledge of the market and its conditions are all points which have been worked for all they are worth. Finally they have advantages in the greater currency of their language in business circles, even in Siberia; the practical nature of their catalogues, price lists and terms; the facilities they offer; the initial risks they are willing to run in order to start business; and in general their undoubtedly superior knowledge of the country and its business customs and ways. The Siberian market is a new one and may develop, and rivals are there seeing that it is not overlooked. Cash payments do not prevail in Russia, and especially in Siberia, where the intermediary has to wait months for his goods and it may be a year or even two for his money. Cash payments are altogether contrary to the custom of the Siberian, long credit being the rooted system of the country. It is clear that on credit terms only can any general business be effected in Siberia. Cash on receipt of bill of lading is quite out of the question. Perhaps in some big lines with big firms engaged on either side, as, for instance, with dredges in gold mining machinery, where competition is less general, such terms have to be accepted by the buyers, but in most branches German or other goods equally serve the purpose demanded, while German or other credit terms are offered and accepted. German goods pierce their way through into remote Siberian towns. Rarely do you find British machinery or tools there, it being generally German or American goods that are to be seen, British catalogues are too often regarded by the Siberians as undecipherable puzzles. F. C. C.

London.

The University of Pennsylvania received $25,000 from Burnham, Williams & Co. as a Christmas present for the new engineering building. This is the second gift from the Baldwin Locomotive Works for the school of engineering.—*Railway Age.*

Automobile Construction—VI.

BY F. C. MASON.

BRAKES.

The brake illustrated in Fig. 16 is of the Raymond type and there are many good ones made on this principle. The assembled brake is shown in front and side elevations and details of the component parts are given.

The brake drum should be a steel or malleable casting. Parts *A* and *B* should be of bronze; parts *C*, *D*, *E*, and *F*, of machine steel. The brake band should be of sheet steel, about 20 gage, lined with leather.

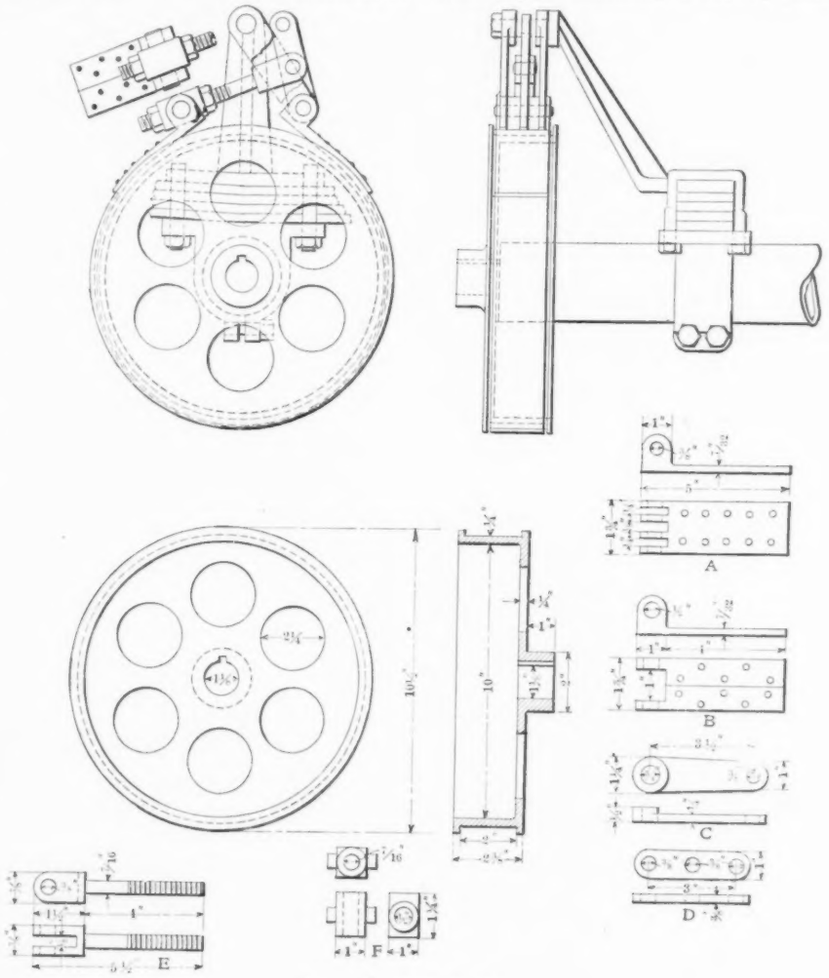


FIG. 16. THE BRAKE.

For light and medium weight cars the brakes are very serviceable as well as cheap to make. On the larger and more expensive cars a great many are using a combination of this brake and an expanding one on the inside of the drum. They use the outside one ordinarily and the inside one as an emergency brake.

THE MUFFLER.

The muffler or "silencer" as our English cousins call it, has received about as much attention as the carbureter and there are many good ones on the market. The same principle is used in nearly all, but the method of application varies greatly.

The one shown in Fig. 17 is one of the simplest as well as the most efficient of any which I have ever tried. For auto use it would be advisable to make the heads of light brass castings, the shell of steel tubing or galvanized iron, the pipes of 1½-inch gas pipe, each pipe to have many ¼-inch holes drilled through to slightly exceed in total area the area of the pipe.

The shell should be, for the engine which I have described, about 24 inches long and 4 inches diameter inside, the exhaust pipes extending in about 9 inches at each end. There is very little back pressure with this muffler. I have shown a cut-out in connection with the muffler and I think the arrangement is novel, as it allows a straight discharge from the engine.

CARBURETERS.

The device used for the vaporization of gasolene, is commonly called a carbureter; formerly it was called a generator or vaporizer. They all answer the same purpose and I suppose that the word carbureter is strictly speaking the correct one whether it is a float feed or valve type. The float feed is used principally for the purpose of keeping a constant gasolene pressure and thereby maintaining a more even regulation of the supply.

In the poppet valve type, which was the old style, if the tank was full you would have more pressure and consequently would have to regulate the needle valve; as the gasolene went down you had to resort to further regulation.

In designing a carbureter some way must be provided for thoroughly vaporizing or mixing the gasolene with the air. To get the proper amount of air and gasolene at all speeds of the engine and thoroughly mixed is not an easy matter to accomplish.

There are hundreds of patents on carbureters and they have been highly improved in the last year. I would not attempt to say which is the best one. One that might work perfectly on one make of engine would not work satisfactorily on another engine. They must be fitted and adjusted to the engine to give entire satisfaction.

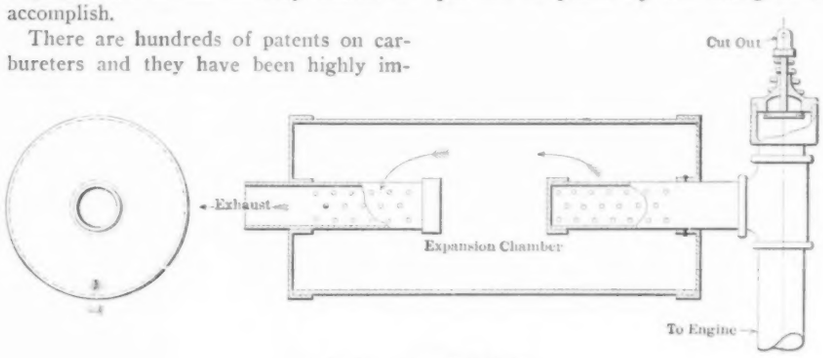


FIG. 17. THE MUFFLER.

An automobile engine is the hardest test of all as the vibration will give a greater or less supply, and it is very difficult to make a carbureter to overcome this.

The carbureter shown in Fig 18, I designed about 1½ years ago and it gave excellent results. It is a perfect mixer. The fan revolves very rapidly by the suction of the engine and thoroughly pulverizes the mixture. It has a very flexible control by the throttle and the only bad feature would be the change in level of gasolene if the carbureter was put out of plumb by the tilting of the car caused by uneven roads. The newer types have a control float to overcome this, which is a decided improvement.

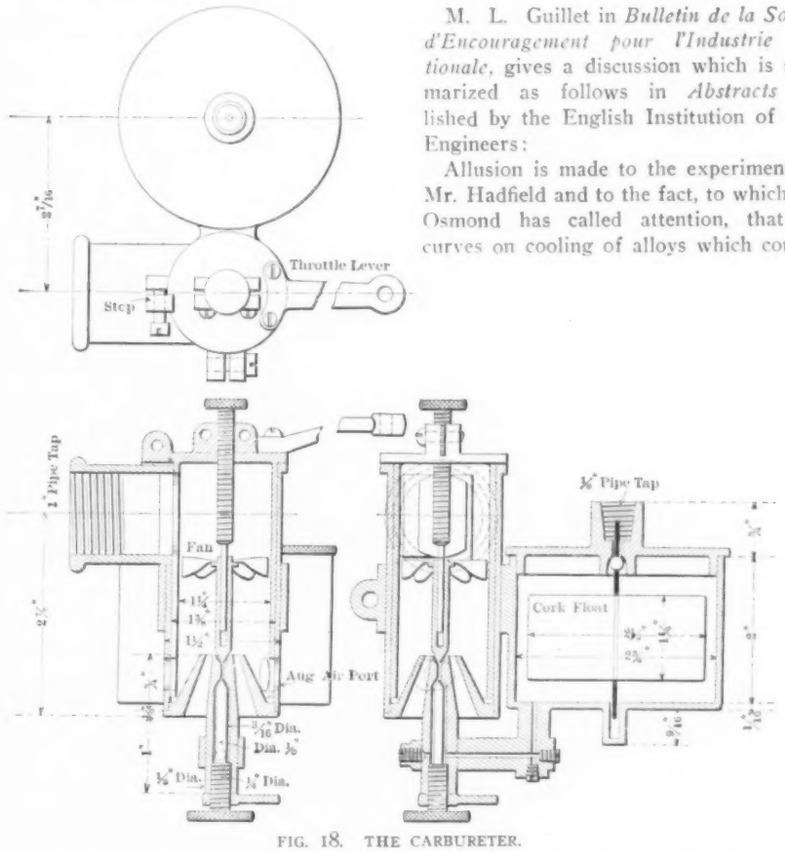


FIG. 18. THE CARBURETER.

Aluminum Steel.

M. L. Guillet in *Bulletin de la Societe d'Encouragement pour l'Industrie Nationale*, gives a discussion which is summarized as follows in *Abstracts* published by the English Institution of Civil Engineers:

Allusion is made to the experiments of Mr. Hadfield and to the fact, to which Mr. Osmond has called attention, that the curves on cooling of alloys which contain 5 per cent. of aluminum would appear to indicate that the aluminum maintains the iron very largely, if not entirely, in the condition prevalent at the ordinary temperature at the point of fusion. The author affirms that his own experiments would appear to verify this hypothesis. These experiments have been conducted with two distinct sets of samples, the one series containing in all cases about 0.150 per cent. of carbon, the other with about 0.750 per cent. of carbon. In each series the proportion of aluminum was steadily increased from 0 to 15 per cent. Complete analyses are appended of all the samples. With one exception all the test-pieces were malleable. Micrographic diagrams are given of the various alloys, picric acid being employed in most cases to attack the polished surfaces. Certain of the specimens with 15 per cent. of aluminum show an entirely different micro-structure, which the author considers must be caused by the presence of a constituent resembling cementite. The perlitic structure of the set of samples with but little carbon prevails also throughout most of the specimens containing the higher percentage of carbon. In the high carbon sample with 10 per cent. of aluminum, however, a change is evident in the structure, and the special constituent resembling cementite found in the first series makes its appearance. A specimen of steel with 0.890 per cent. of carbon and 15.2 per cent. of aluminum gave absolutely abnormal results, which are illustrated in several photographs indicating the appearances in adjacent test-pieces when various fluids were used for the attack. This alloy varied in different parts, and seemed to consist of perlite and ferrite, together with a network of acicular crystals almost white in color, which last may be the constituent resembling cementite in character, and there are traces of a new body which may be ferro-aluminum. It follows from the foregoing that aluminum becomes dissolved in the iron, that this solution hinders the formation of perlite and compels this constituent to assume a granular condition. Graphite is not formed, as might have been anticipated, seeing that aluminum precipitates carbon in gray iron. With high percentages of carbon and aluminum a constituent is found which has the characteristics of cementite. The author gives a series of tests of cementation and tempering which appear to confirm this conclusion, and the results obtained are set forth in tables and graphic diagrams. His general conclusions, based on these experiments, are as follows:

Aluminum has not any very important action on the mechanical properties of steels while the percentage remains low; above 2 per cent. to 3 per cent. it causes great brittleness in the metal.

Up to 15 per cent. of aluminum there is no formation of ferro-aluminum; the aluminum becomes dissolved in the iron. The solution of ferro-aluminum thus formed does not dissolve the carbon, and the perlite assumes a special granular form, which explains the brittleness of these alloys.

Letters to the Editor.

A Convenient Hoisting Rig—Plugging Holes in the Floor.

Fig. 1 shows a scheme which I have used for hanging a hoist over a lathe or planer where the regular cranes did not reach and where the amount of heavy work to be handled would not justify a more expensive outfit. Two I-beams *A A* (or for light work, pieces of railroad iron) are clamped up under the floor timbers. Resting on these is a third beam *B*, which can be placed anywhere across the two, either square or at an angle. It is secured from slipping off endwise by pins or bolts put through at the ends, as at *C*, far enough apart so that the beam can be laid across diagonally. A single-wheel trolley *E* runs on this last beam, to which any spare hoist may be hung. It will be seen that this scheme saves having a lot of holes through the floor overhead, and also that it is easily adjustable to suit the tool and the work. Suppose the lathe is placed at right angles to the timbers and a heavy piece is to be put in. Hang up the hoist, run the work up alongside and hitch on. Lifting once to get the work balanced, it is easy to tell how much the overhead beam must be moved to bring the work right lengthwise of the lathe. Letting it down again, push the upper beam over with a pole till it is about right and then hoist away, with the trolley square over the load. Hoist to the right height and push it over till it centers right.

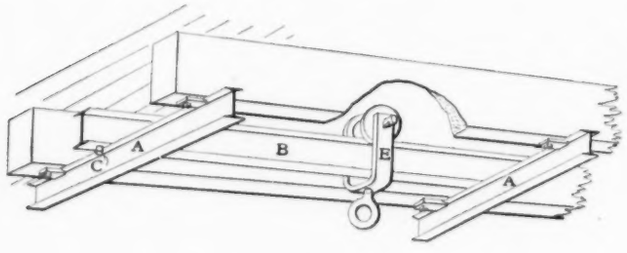


FIG. 1. A CONVENIENT HOISTING RIG.

Those who have had to put much stuff into a lathe with a single hoist hung over the centers, and have had things slip occasionally, to the detriment of handles, etc., will appreciate the beauty of this arrangement, and with a lean pocket-book comfort can be obtained from its simplicity.

If holes must be bored through the floor to hang up hoists, get a few gray-iron plugs like Fig. 2, with good long stems, an eighth of an inch smaller than the holes to be plugged. They beat a cork or a wooden plug all hollow when the hole is needed again, and they save a lot of chips falling on the tools below when sweeping up. While these holes are not as bad as Chordal's open hatchway, with occasionally an apprentice boy coming tumbling down, a scriber coming through may be just as bad for the man below.

E. H. FISH.

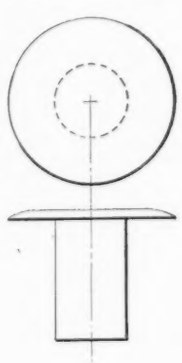
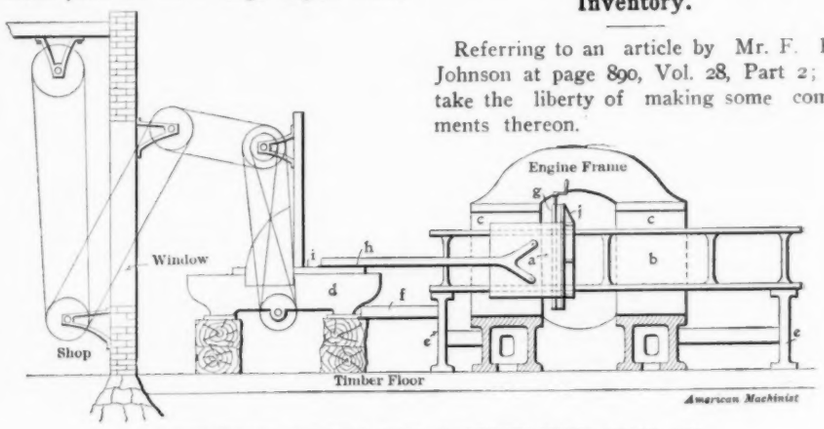


FIG. 2. A GRAY-IRON PLUG.

How Heavy Castings Were Machined Forty Years Ago.

A long time ago I promised to send you sketches of special fixtures that were employed to machine heavy castings forty years ago. The rough sketch shows an improvised shaper to plane the pillow-block jaws *c c* of a large engine frame which was too large to handle in the machine shop and had to be done in the yard. The drive is from the main line-shaft in the machine shop; through a series of jack-shafts the power is transmitted to a small planer mounted on timbers. The engine frame is also secured to timbers let into the ground, which was the best we could afford in those days for floor plates. This method of planing large castings was very popular before the advent of portable tools.



HOW HEAVY CASTINGS WERE MACHINED FORTY YEARS AGO.

The casting *b* is made similar to an I-beam, with ribs on both sides of the web, planed 14 by 24 inches by 14 feet long and carried on two gray-iron supports *e e*. The saddle *a* is made in two parts and fitted to the beam *b*. The saddle *a* has a continuous flange *j* on four sides near one end to carry one or more tool slides *g*. The brace *f* between the planer and support *e* make the whole outfit self-sustaining. There are two side connecting rods *h* with forked end secured to the planer platen *i* and saddle *a*. The saddle *a* is actuated by the planer platen *i*. The connecting rods *h* are lengthened or shortened to suit the position of the work.

I have used this method for planing all kinds of heavy work and find it very handy to set. It does work more accurately than large planers, as it is rigid and brings the cutting tools close to the work.

GAFFER.

A Modern Method of Taking an Inventory.

Referring to an article by Mr. F. B. Johnson at page 890, Vol. 28, Part 2; I take the liberty of making some comments thereon.

The plan outlined by Mr. Johnson was suggested by me some two years ago while connected with a large electrical manufacturing company, but in a somewhat more complete form.

The first and most essential thing is to have made up, before inventory taking actually begins, a classification of all parts, material, etc. In most shops this would be done by department heads, but uniformity of classification must be adhered to, that is, all material of similar kind should have the same classification number prefixed by the proper department symbol. In most cases it would be desirable to have the classification arranged for different types or sizes of machine or apparatus made by each department.

To illustrate, we will say *M* stands for motor department and *ac* ½ will be assigned to a particular type and size of machine. The classification entered on the card would be *M-ac* ½, if the card contained any part or material of that particular size and type of machine.

The cards are sent as soon as filled, to those who are to do the classifying and they mark thereon the classification number or symbol. They all go to one department first where those that pertain to that department only are picked out and classified, passing all the others to the next department. Those that are classified are next turned over to those who are to do the pricing. The extending and

tabulating are to be done by all the available clerks during the inventory period.

The method as outlined is very flexible. As the cards are all classified they can be arranged in any manner and such results as are desired first can very readily be gotten.

Inventory taking is usually a slow and expensive process and any system that will insure quick results will be appreciated by many, I am sure. It is to be hoped that the subject started by Mr. Johnson will bring out a full discussion, as there has not been very much general information on this most important question brought before your readers.

HARRY W. JEANNIN.

Portable Key-Way Miller.

The portable key-way milling attachment shown by the accompanying drawing will doubtless prove of interest to machine builders who have to do with large crank shafts and axles. I have seen many cases where this tool has been almost indispensable and have also seen cases where if the tool had been known one would surely have been made.

This particular tool was made for use on shafts from 7 to 10 inches in diameter and larger. Fig. 1 shows the position the tool takes on shafts of the above named diameters. No doubt most of the up-to-date engine builders have their shops well equipped with the necessary traveling cranes and large milling machines to handle their large shafts in a speedy and economical manner; but I venture to say not one of them could do a more rapid and accurate job that can be done with this tool with the aid of one of the handy air drills as the motive power. If there happens to be no air drill of sufficient power to drive the particular size of mill that is required by direct connection to the Morse taper shank *A*, then a reduction gear can be slipped over the shank and one of the smaller size air drills may be used. Another method is to level up the shaft under a modern long arm radial drill press. The shaft does not have to be lined up to a dead certainty so that the milling cutter will follow accurately the center line of the shaft, as is the case with the milling machine; all that is necessary with this tool is to get the shaft level enough for the drill head to get a good parallel grip on the socket *A*.

The mills are made in one piece and in as many different sizes as the standard key-ways for different diameters of shafts require; the shafts are all the same size and made to fit the mechanism in the head *B*. The main slide *C* of the tool may be made any length to suit the maximum length of key-way you may wish to cut; this particular tool the plan of which is shown in Fig. 2 is 12-in. long, with an effective travel of 8 in. for the head *B*. The upward thrust of the mill is taken by twenty 3-16-in. steel balls in the race *DD*, and the race is held in place by a spiral spring of No. 14 spring steel of five coils. The vertical feed for the mill is operated by the adjusting nut *E* which is nurled around the periphery of the wheel. The longitudinal feed is through the screw *F* (13 threads) operated by the nurled hand wheel *G* which is locked to the feed screw by a 3-16-in. taper pin *H*. The V-shaped slide for the head *B* is formed by the side strips *KK*, which are secured to the main casting with 3-8-in. tap bolts, making it easy to adjust and keep the tool in perfect alinement. The tool as a whole is held to the shaft or axle by means of the chain clamps *L* and *M* which form a ball joint through the circular washers *NN*. The chain *M* is made up of two links and a hook while chain *L* is made entirely of links.

BAYARD.

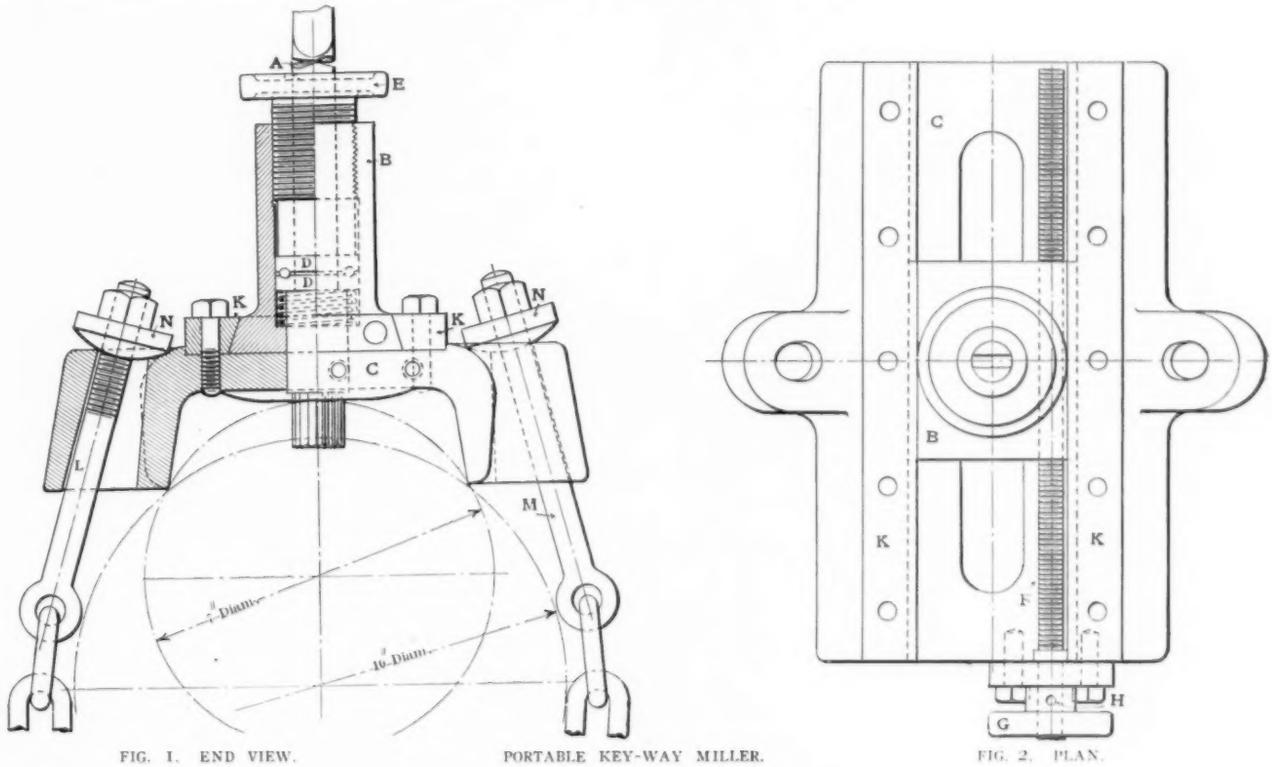


FIG. 1. END VIEW. PORTABLE KEY-WAY MILLER. FIG. 2. PLAN.

System in Numbering.

One is often surprised to see how systems will grow up of themselves and prove successful in spite of inherent defects of method. In any concern that has grown from small beginnings there will always be survivals of the early days in methods or nomenclature even if the payroll has ten thousand names on it, and happy indeed is the executive who can carry through a general reformation of methods and systems.

One thing that will always strike an observer is the great numbers of series of numbers such a concern will carry.

For example there will be contract numbers, drawing numbers, sketch numbers, pattern numbers, order numbers, etc., etc. One concern adopted the expedient of prefixing a letter to each series and has used all the letters of the alphabet. The result is always more or less confusion, especially where two or more series cover similar lines, as drawing and sketch numbers. This often eats into

money and always causes delays and bickerings and is generally merely a survival of the days when every man made his own system.

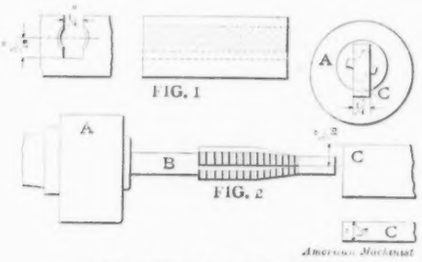
The proper course would be to number everything from one series, that is, assign numbers 1 to 9,999 inclusive to contracts, 10,000 to 99,999 to drawings, 100,000 to 200,000 for sketch numbers, etc., etc. This makes the numbers used large but never over seven figures, while nearly all lettered series run into six with a letter.

Every number has a definite document and only one. All confusion due to misunderstanding is reduced to a minimum and the system is greatly simplified.

F. W. HARRIS.

Tapping a Slotted Piece.

Fig. 1 in the sketch shows a finished job the machining of which for a time seemed



THE WORK AND THE TOOLS.

a hard nut to crack. It was desired to have a slot with the sides threaded as shown and yet have the center line of the tap perfectly parallel with the sides and bottom. The method by which they had been done and which did not prove satisfactory, was to drill and tap the hole through the block, then cut the slot as nearly as possible through the center of the hole. However, by this method the drill would almost invariably lead from the desired center, especially if the material, which is gray iron, was irregular.

The device shown in Figs. 2 and 3 was made for the work and gives a practically accurate job, and it requires only about one-tenth the time used formerly for machining. Fig. 3 is an end view of Fig. 2. In Figs. 2, *A* is the tapping chuck, *B* the tap, and *C* is a strip of steel securely fastened to the slide of the lathe, central and parallel with the tap. The distance from the top of this strip to the center of the tap is equal to the distance between the bottom of the slot and the center of the tapped hole, as shown in Fig. 1. The width of the strip is the same as the width of the slot, making a neat sliding fit.

The work is first slotted and then set over the strip *C*, the top of the strip coming in contact with the bottom of the slot. The work is then pushed over the plain end of the tap, which is of a diameter equal to the width of the slot, and up over the tap until threaded as desired, when, with a backward pull, the tap backs out.

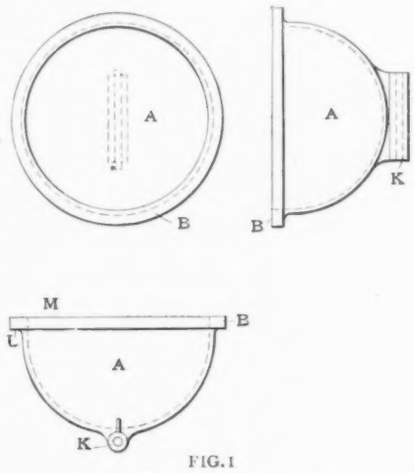
The time required for tapping is about ten seconds. The work is done on a speed lathe and the cutting speed of the tap is high. The machine need not be stopped while the work is being changed, as a squirt of oil is sufficient to keep the tap free from cuttings, and the workman is kept busy handling the blocks fast enough. But the most pleasing feature of the device is that it gives exactly the required results. The strip *C* brings the slot in line and the nose on the end of the tap centers it perfectly, so it is almost impossible to tap out of square no matter how careless or inexperienced the operator may be.

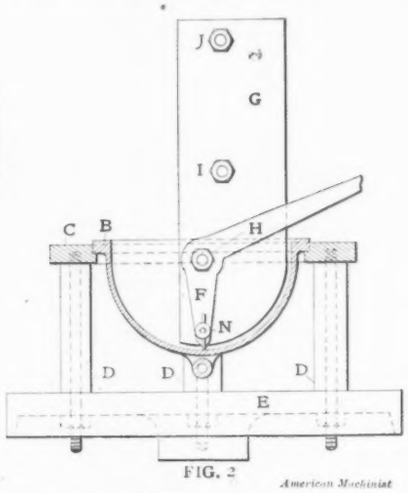
B. LANDIS.

Turning the Interior of a Hemisphere.

Fig. 1 shows a job which was brought into the shop some time ago. There were two steel castings, about 8 inches inside diameter, both off the same pattern. The job was to be turned and threaded on the circumference of the flange *B*, the faces *L* and *M* finished and the inside turned approximately central with the outside. As there were only two pieces to do, the price would not permit of any considerable amount of rigging up. The castings were excellent, true to pattern and soft.

A spider was fitted across the face of





TURNING THE INTERIOR OF A HEMISPHERE.

the flange and centered. The lug—through which is the hole *K*—was gripped in a four-jaw chuck, with two of the jaws reversed, and the tail center was brought up against the spider. When held thus the outside of the flange *B* was threaded, and the inside of the flange at *L* faced off. Owing to the spider overlapping the face *M* of the flange, this could not be faced at this setting. Both castings were finished thus far before the next operation.

A gray-iron ring *C*, Fig. 2, was then secured to the face-plate *E* by means of studs passing through four distance pieces *D* made of common pipe. *C* was then threaded to receive the threaded flange of *A*, a shoulder being left for the face *L* to abut against. A piece of boiler plate *G*, 1 inch thick, by about 5 inches wide and 3 feet long, was then roughly sheared at one end to a segment of a circle slightly less than that of the inside of *A*. A stud was put in this at *H* for a fulcrum for the lever *F*. A bolt *I* secured *G* to the tool slide, and a bolt at *J* reached to a clamp under the bed, preventing *G* from tilting forward when a cut was being taken. The end of *F* was provided with a small tool-holder *N*, taking 5-16-inch square steel. The other end was offset to clear the bolt *I*, and was about 4 feet long, so that although the feed was by hand lever, the movement of the handle being 12 to 1 of the tool the job was as smooth as necessary. Behind *N* a hole was drilled to take the shank of a small planer stop with a screw in it, this was used to feed the tool to the cut. After finishing the circular cut the short straight part at the mouth of *A* was bored, and the flange at *M* was faced—*G* having been first removed from the tool slide. The hole *K* was bored with a bar between centers, the face *M* of the castings being clamped to parallels on the carriage. Subsequently a number of these castings were ordered and a toothed segment was secured to the handle end of *F*, and the surplus length of *F* cut off. This was then actuated by a worm mounted on bearings secured to *G*, engaging with the segment. This made a much neater and more efficient fixture.

DIXIE.

A Belt Puzzle.

Referring to the belt puzzle at page 62, it is to be expected that belt *b* will gain about one inch in each running foot when driven from pulley *a*, since it is practically driven by a pulley 3/8 inch longer than is belt *d*. The puzzle lies in the fact that belt *b* still gains when pulleys *c* do the driving. I believe this is due to the fact that there is less friction between the belts at *c* than at *a*. If such a condition existed, then in the first case belt *b*, running at a faster speed than drivers *a*, would drive idlers *c* faster than *a*. In the second case belt *b*, running at the same speed as drivers *c*, would drive idler *a*

slower than *c*. Thus belt *b* would always be gaining on belt *d*. It would be very interesting to have Mr. Schumacker report whether or not this is the case. The remedy, I believe, is to let both pulleys *a* and *c* be idlers and drive the belts independently from some other source, say the two outside pulleys. W. DEATS.

Home-Made Straightening Press.

We have had a lot of structural iron to straighten and the old way of straightening it was by a hand-screw, requiring from four to eight men, and a long double end wrench, which consumed a lot of

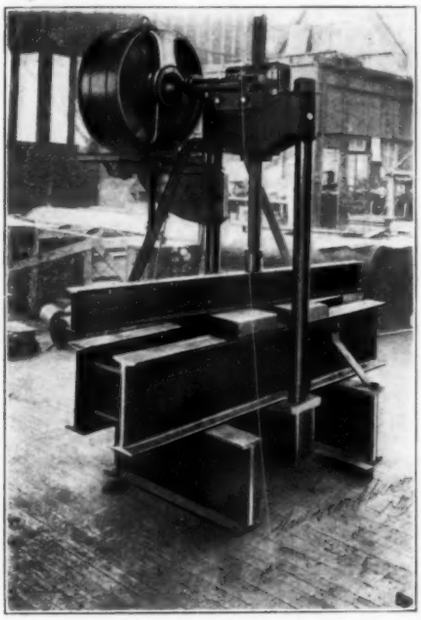


FIG. 1. HOME-MADE STRAIGHTENING PRESS.

time for a small amount of work. So in order to do the work better and quicker. I designed the power press shown herewith.

The base of the press is made of 15 inch I-beams, bolted together, and fastened to the floor by lag-screws. The two upright rods are made of 2½-inch machine steel with a nut at each end, and two 2½-inch steel pipe separators, that keep the upper crosshead in permanent position. The lower ends of the rods go between two 10-inch I-beams that have a plate bolted at top and bottom to keep the rods in an upright position. The method of fastening the I-beams and rods can be seen in the rear view in Fig. 2.

This view also shows the method of mounting the worm-shaft at the rear of the crosshead. The nut for the screw is made of bronze and is forced into its seat in the crosshead from the underside and up against a shoulder so as to maintain a permanent position, while the screw is pressed hard against the work that is being straightened. The worm gear has a hub that extends down into the crosshead about 5 inches, which gives it a good, solid bearing. The worm has a ball-thrust bearing to reduce friction.

The feather that drives the screw is fastened into the worm gear and slides in the keyway as the screw is turned up or down. The screw is 3 inches in diameter and 4 feet long, with four threads per inch and has been used continuously for two and one-half years without showing any material wear. The machine is driven by a fifteen horse-power Bullock motor, operated on the multiple voltage system and using direct current at 240 volts, and will straighten 4-inch square machine steel on a 20-inch span. A fuse or circuit breaker forms a safeguard in case of excessive overload, though there has as yet been no trouble on this score.

The press could, of course, be arranged for belt drive if desired. It can be used for all kinds of work within its capacity, by employing two men, and a large variety of work can be handled by one operator alone. W. A. WATERMAN.

The External Spring Indicator.

I am somewhat interested in the article at page 895, Vol. 28, Part 2, respecting the External Spring Indicator, but at the same time must confess that I am in doubt regarding some of the statements made.

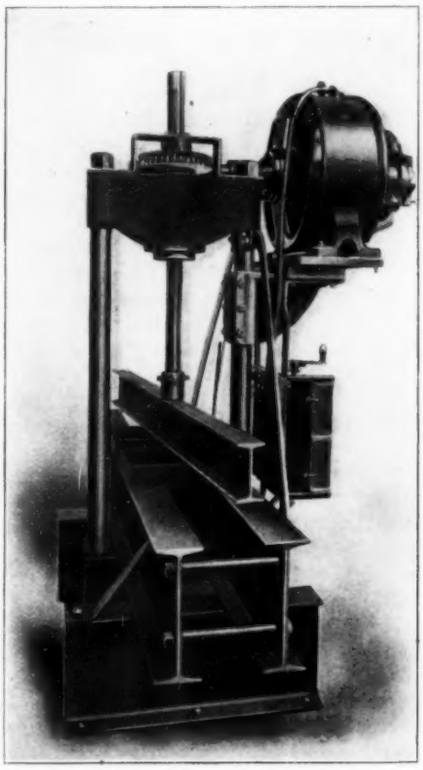


FIG. 2. REAR VIEW OF PRESS.

(1) In the first place I fail to see why the location of the spring outside the cylinder is "obviously correct," as it seems to me that where a tried method is being compared with an experiment, the old and sure way would usually be considered "obviously correct" until the new idea had proven its worth.

I consider that the external spring is less liable to "burn the operator's fingers," but I have always considered that there is more to the indication of engines than the protection of the operator's fingers, and have always thought that the consulting engineer who adopts an indicator which is not correct, is liable to "burn his fingers" in other ways, by depending upon a result which is not correct.

(2) I have always thought that the internal spring is subjected to less variation in temperature than the external, and I have the most eminent authority to substantiate my views that the temperature acting upon an internal indicator spring is not sufficiently high to injure its elasticity, either temporarily or permanently.

(3) It is true that the internal spring indicator is not as accurate for hydraulic work, but it is doubtful if one indicator out of five thousand is ever used for this purpose. I would also like to have it explained to me how the spherical form of the piston illustrated "obviously prevents binding," as I think that any side thrust of the piston due to the imperfect action of the spring would be just as serious in its results as with the old form of piston.

(4) I would also like to know how the increase in the weight of the piston offsets the increase of weight in the reciprocating parts, as in my opinion, it would simply increase the error instead of diminishing it. I am of the opinion that the thousands of perfectly satisfactory internal spring indicators carry sufficient weight to make it doubtful whether the outside spring type will relegate the older form to the "upper shelf" until it is demonstrated that the external spring type gives more accurate results to reward the purchaser for the greatly increased cost. ROBERT G. FOLSOM.

[(1) The fact that a thing is customary does not make it obviously correct. The external spring indicator is no longer an experiment.

(2) Our article says: "In tests of the two ends of pumps or air compressors the location of the spring within the cylinder leads to a hot spring for one end and a cold one for the other;" which shows plainly enough the source of the variation in temperature to which we referred. We said nothing about any injury to the spring due to the heat, but gave as an advantage of the external spring that it "gives a uniform scale regardless of the temperature of the cylinder indicated" which the internal spring does not.

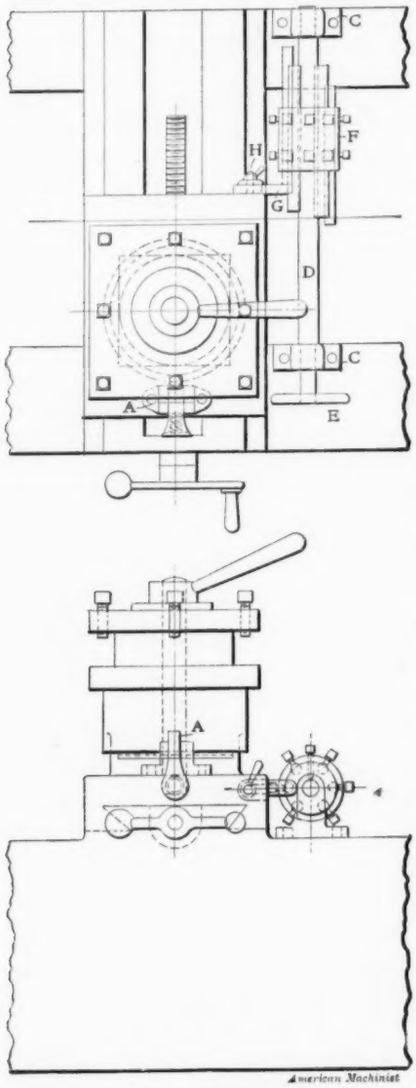
(3) We fail to see how it is possible for the spherical form of piston to bind in the cylinder, whereas it is easy for the usual form to bind in case there is any canting action of the spring, to which action the compression spring used in internal spring instruments is especially

liable. With the extension spring used in the external spring instrument such action is practically impossible.

(4) With a larger piston the absolute weight of the reciprocating parts is increased, but the relative weight compared with the forces acting is, other things being equal, reduced. The external spring involves an increase in the absolute weight of these parts which an increase in the diameter of the piston thus offsets.—Ed.]

A Lathe Transformed Into a Turret Machine.

The only turret lathe in the shop was so crowded with work that two ordinary



A TURRET FITTED TO THE LATHE CARRIAGE.

lathes had to be run on the same job. The production of the lathes was disappointing, and served to prove the usefulness of the special machine. Buying a new turret lathe was out of question, for the rush was only temporary, and it was thought of transforming one of the lathes into a turret machine, which was done at a light expense, as shown in the sketches.

The compound slide was removed and a fitting turned for the turret, whose simple construction is clearly shown in the sketch, which also shows at *A* a combination of a bracket, latch and spring to lock the turret at four different positions. The turret stop consists of two brackets *C C*, bolted on the carriage; a shaft *D*, handwheel *E* and muff *F* that has six rods of convenient lengths. On the cross-slide is a strap *G* with a long slot. Bolt *H* is square at the base to fit the slot of the strap, and has a nut with a handle. To turn muff *F* the strap is brought back to be pushed forward and fastened when the muff is in the right position. In this way the production of the machine was doubled.

J. M. Menegus.

Visiting Shops—English and American Workmen.

In the leader at page 828 you gave an interesting example of shop practice in viewing works by visitors, and I should like to give you an experience of mine. I was recently appointed secretary for a paper and workshop visiting scheme in a new and large electrical firm in Manchester. Among the various tool and other shops to which I wrote for the pleasure of a visit was the works of Messrs. Hans Renold, Ltd., chain manufacturers, of Manchester, and received in reply a request for the number who would go, which was about 40. We were received at the entrance and taken to the finished stores and shipping department and greeted by our conductors and the secretary of the firm, who explained some of their processes and showed us the finished parts. We were then split up into four parties, the first taking the basement, the second the first floor and so on. At the end of 20 minutes a bell was rung and the parties changed floors and conductors and were taken through the other parts of the workshop. In this way everybody had the same chance of instruction from the conductors, who were foremen of the respective departments. We then had tea in the dining room and after a most agreeable time left with a recollection of at least one afternoon spent in the most enjoyable way possible.

Half our company were Americans, and their praise and approval of the way they had been treated and conducted and of the kind of shop practice they had seen was gratifying to myself as an Englishman.

Having had some experience in English and American workshops, I have found a great difference in their workmen. In England if a man has a piece of work to perform he hunts around for some tackle to do the job with and may hit on some ingenious scheme to do it, but he always seems a little ashamed of it because it sometimes is not a beautiful thing to look at, although the idea is there and if well made the rig would save money. I find on the other hand that in American workshops there is no desire to hide your head under a bushel, as the workmen will not let you rest until they have shown their work, and taking all things into consideration, the American has the advantage.

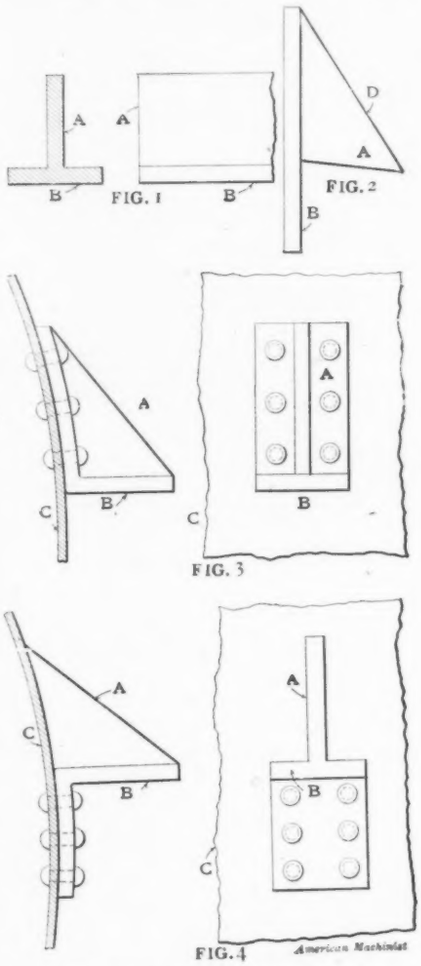
Nomad.

Saltley, England.

Boiler Brackets From Rolled Shapes.

Having noticed in different publications methods of making boiler lugs from steel plate, by cutting the plate to a certain shape and then forming it under a press having the required dies, I enclose sketches of a method of making such lugs without the use of a press and dies.

These lugs are made from a bar of structural iron known as "T" iron. Fig. 1



BOILER LUGS FROM ROLLED SHAPES.

shows an end and a side view of such a bar as it comes from the rolling mill, *B* being the base and *A* the rib. Fig. 2 shows how a piece has been cut from the bar and the rib cut away on the lines *A, B* and *D*, permitting the base to be bent up against the remaining part of the rib, as shown in Fig. 3, which shows the finished bracket or lug shaped to the curve of the boiler shell *C* and riveted to it. The angle of the cut *A*, Fig. 1, obviously depends on the curve of the boiler and the position of the bracket.

Fig. 4 shows another style, also made from "T" iron, by cutting the rib and base apart where they meet or at the angle, and then bending the base down and shaping it to the curve of the boiler, the rib being also shaped to the same curve.

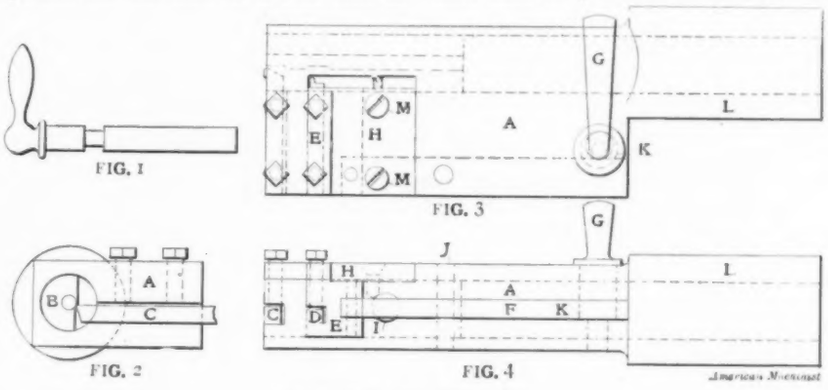
C. W. J.

Tool for Finishing and Recessing a Brass Stem.

The sketch shows a tool we devised for finishing the brass casting shown in Fig. 1. These castings are turned 15-64 inch diameter, with recess 7-16 inch long; diameter at the recess, 11-64 inch; total length to be turned, 4 inches; the idea of the fixture being to finish the piece at one chucking, and avoid the use of the master chuck that had previously been used. The success of the device can be judged from the fact that its output is forty-five per hour. The recess is the most difficult part to deal with. Fig. 2 gives merely the face of the device, the other details having been left off for the sake of clearness. It shows the position of the tool *C*, which cuts the piece to size; this tool, of course, is about 1-32 inch ahead of the bushing. The body *A* is made of soft steel. The bushing *B* is of tool-steel, hardened, the bushing being cut away as shown to provide clearance for the chips. The tool *D*, which cuts the recess, is held in the sliding-block *E*, which is fitted in the body *A*, a snug sliding fit. The plate *H* acts as a gib. The lever *F*, which operates the tool-slide *E*, has its fulcrum at pin *J*. At *I* is a coiled spring. The handle *G* has an eccentric at *K*; it is also provided with a stop which allows it to turn one-half revolution. In operating the device the handle *G* is at the position shown in the sketch. The device is advanced on the work until the tool *D* is at the point where the recess is to be cut; the handle *G* is given one-half turn, which sets the tool to proper depth; the device is then advanced to finish the cut; a half turn of the handle *G* releases the tool *D*; the device is then drawn from the work, leaving it finished. The space *N* is cut clear through, leaving a space for chips to drop out, also a place to observe the action of the tool. As this tool works in clean brass it very seldom needs grinding or adjustment.

W. T. H.

Missouri.



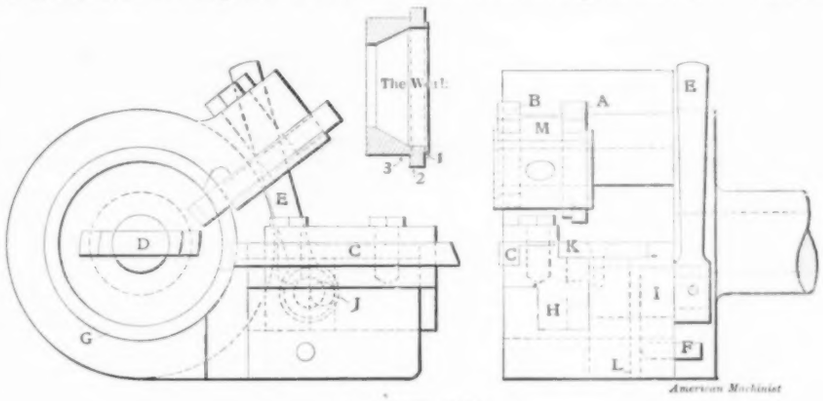
THE WORK AND THE TOOL.

A Turret Tool.

The sketches show a brass piece and a tool we devised for finishing it. It is necessary for the inside and outside to be true with each other in order to insure proper working. As we had no lathe with hollow spindle large enough to allow the bar to go through the spindle, an undercut or broad-faced forming tool was out of the question. With this tool the work is finished complete, with the exception of cutting off.

The tool *A* finishes the end 1 and the outer face of collar 2, the tool *B* finishes the diameter of collar 2. The tool *C* finishes diameter 3 and the back of collar 2. The inside is finished with a formed flat cutter *D*.

Before using the tool, the work (made from a brass plug cast long enough for six pieces) is rough turned and bored, in order to avoid working the tools against the scale. The tool, with handle *E* in the position shown, is fed on the work until the end and bore are finished, and is then drawn back until the tool *C* is in the right position for forming the back of collar 2. The handle *E* is then pulled down until it strikes the stop *F*, thus forcing the tool *C* in to the right depth for turning the body behind the collar and also facing the collar. The turret is again advanced to finish the diameters 3, and the handle *E* then thrown over to withdraw the tool from the work, leaving the latter ready to be cut off.



A TURRET TOOL.

The body of the tool is gray iron; the bushing *G*, tool steel, hardened; the tool-block *H*, soft steel, case-hardened. The cutter for the bore (an ordinary flat cutter formed to the required shape) has a shank fitted to the hole in the shank of the casting. The cutter and bushing are not shown in the side view. The bushing extends back 1-16 inch over the cutting edge of tool *A* in order to avoid raising a burr on the edge of the work. The shaft *I* has at one end a pin *J* turned eccentric, and the tool-block *H* has a vertical slot planed at this point for the pin to travel in when the block is being operated. The plate *K* is fastened by two 18x24 machine screws and the shaft is held in place by the pin at *L* and a retaining groove cut around the shaft. The block *M*, carrying tools *A* and *B*, is fastened by means of a 7-16 inch cap-screw, and is also doweled to prevent turning. A large hole drilled through the body just back of the bushing and the opening below the point of tool *C* provide ample room for getting rid of the chips.

W. T. H.

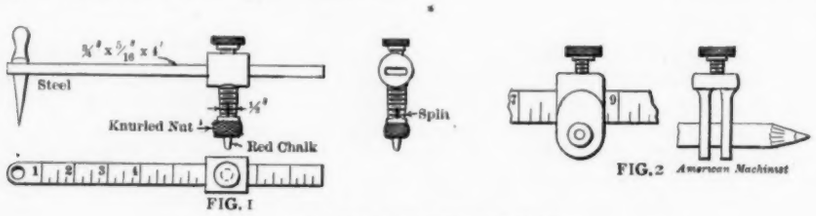
Drawing Room Practice.

I have read with interest H. F. Noyes' article on "Drawing Room Practice" at page 855, Vol. 28, Part 2. His system of laying down hard and fast rules is very good, and he is by no means the only chief to do this; but I think he carries it a bit too far. Draftsmen are only human and are generally reckoned to have a certain amount of common sense and feeling. I do not think it is very nice for draftsmen to see their names stuck up on a list with black marks against them, pointing out the fact that on such a drawing there was 25 or more per cent. mistakes. Nobody is infallible, even the best may make mistakes. Why should a draftsman have his faults stuck up in a conspicuous place before all his fellows? Ask yourself, what will it do for him? Will it not lower him in the estimation of his fellows? They will look down on him and mark him as being a "waster.' This will lead to a feeling of discontent among them and will

not tend to smooth the running of the office. Such a system is generally left behind in the elementary schools. Even in shops where men live under harder circumstances, they do not adopt such methods very often. I do not say a man should not have his mistakes pointed out to him. Certainly he should, but in private; also he could be told that he must improve or else he would have to go. I think a good talking to a man in private goes a lot farther toward improving his work than public exposure. CONRAD.

Marking Iron Before Cutting Off.

In some cases the man in our cutting-off department doesn't like to use the adjustable stop on the heavy shear, because he then can't use every stroke. I used to see him very often measure out the pieces with his wooden rule and a piece of chalk; we didn't get the pieces very exact. The sketch, Fig. 1, shows a beam compass, which I designed for him. It has been in steady use for half a year, and he says it is handy and saves him much time. Beside, we get the pieces more nearly alike and it saves its own weight in material



TRAMMEL FOR MARKING OFF IRON.

every day. The red chalk in the holder is sharpened like a chisel; the point then wears better. Instead of the chalk-holder it might be better to make a clamp and use a pencil with red lead, as shown in Fig. 2. A. M. P.

Holeby, Denmark.

Home-Made Sand-Blast Nozzle.

The accompanying sketch shows a home-made sand-blast nozzle which has done good service as a casting cleaner. All parts shown in the sketch are made of brass except the handle, which is a piece of ¾-inch wrought-iron pipe, 6 inches long, screwed into the boss far enough to insure stability. The one-inch pipe tap at the top is for the sand connection, the body being made amply large for the storage of a small amount of sand. The air nozzle is drilled out ⅜ inch for a depth of 2½ inches and the remaining 2 inches is drilled ⅛ inch in diameter. It has been found that the best results are obtained when the tip of the air nozzle is screwed up to within ⅜ inch of the blast pipe. For the air-controlling valve we used to good advantage an old air-drill operating valve, screwed on the end of the air nozzle over the ⅜-inch pipe thread. BAYARD.

Combined Measuring and Calculating Rule.

The idea presented in the scale rule here shown is so good, that it is a pity it is not imitated by American manufacturers. As will be seen from the cut, it is a folding meter-rule. The form itself is about as inconvenient as could be chosen; but all meter measures are so, and since the invention of the patent joint which prevents their collapsing when straightened out, they are like the proverbial singed cat, "better than they look."

To get back to the subject of the sketch—besides serving as an ordinary measuring-rule graduated to millimeters, this device has graduations giving the contents of squares of given length of side, the circumference of circles of given diameters, and the area of circles; besides incidentally enabling the calculation of cubic contents and weights of cylindrical bodies. The figures referring to circumferences are on one side in black; those giving contents are on the other side in red, and on this latter side in black, are also the corresponding areas of squares.

To get the area of a square of 87 on a side—look alongside of the figure 87 and the area is given—in black, 7569.

A wagon wheel is 60 in diameter, the net length of band for the tire is seen to be 1885.

The circumference of a cylindrical reservoir is 785 cm; the diameter is seen to be 25.

A pipe must have a cylindrical cross section of 7584; then the necessary diameter is seen to be 31.

The cubic capacity of a cylindrical reservoir is 48 diameter and 1.5 in height

MEASURING AND CALCULATING RULE.

is got by finding the cross section 1810, and adding half thereof, making 2715.

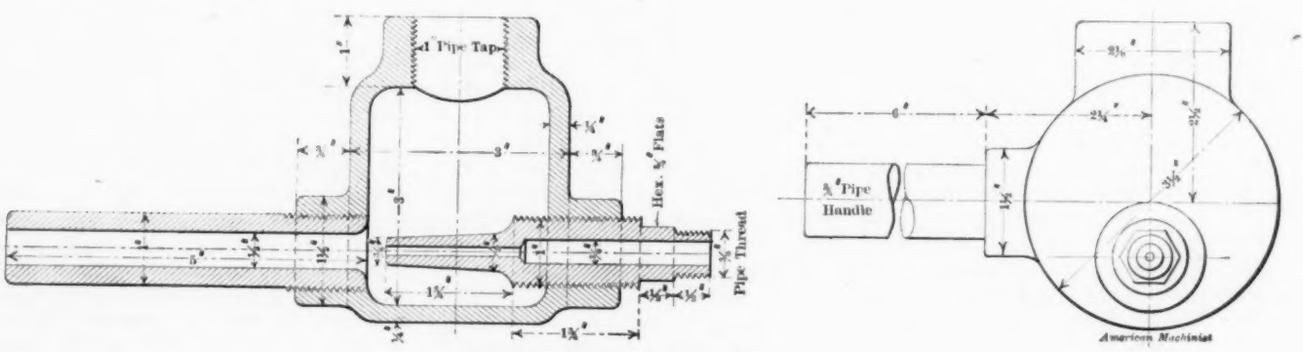
A wire for 100 amperes is to be laid, where it takes one square millimeter per ampere. Then the wire must have 50 mm. cross section, and according to the rule this calls for a diameter of 8 mm.

A tree trunk five meters long and 12 cm. diameter is to be measured for cubic contents. Beside the 12 cm. mark stands 113; the content is therefore 0.0113 x 5= 0.0565 cubic meters. The weight of a round sandstone pillar of 6.75 meters in length and 0.6 meter diameter is to be found. First the cubic contents is calculated—along side of 60 stands the cross section, 2827; 0.2827 multiplied by the length, 6.75 gives the contents, 1.908 cubic meters. As sandstone weighs 2.07 times as much as water, we have 1.908 x 2.07 x 1000 = 3049 kilograms as the weight of the pillar.

The makers are C. A. Schietrumpf & Co., Jena, Germany.

ROBERT GRIMSHAW.

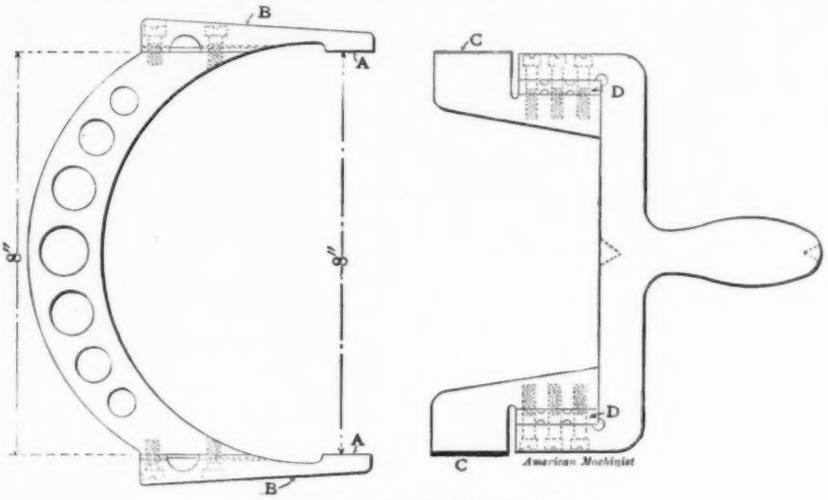
Hanover, Germany.



HOMEMADE SAND-BLAST NOZZLE.

Renewable Size Gages.

The illustrations show inside and outside caliper gages that are easily kept in repair. The outside gage is repaired by taking off parts *B B*, and lapping down



INSIDE AND OUTSIDE CALIPER GAGES.

the surfaces at *A A*, and the seats by which these parts are bolted to the frame. The frame is finished the gage size and maintains the diameter required. The inside gage is repaired by lapping the blocks *D D* to bring *C C* out to size.

I. N. QUIRE.

Jig for Holding Light Cylinders While Being Bored.

The enclosed sketch, Fig. 2, illustrates a fixture for the lathe used in the boring of the aluminum cylinder shown in Fig. 1, insuring a more accurate hole than were the thin shell clamped in an ordinary chuck. The end of the cylinder *N* is faced and this flange turned to size. The inner side of this flange is also roughly trued

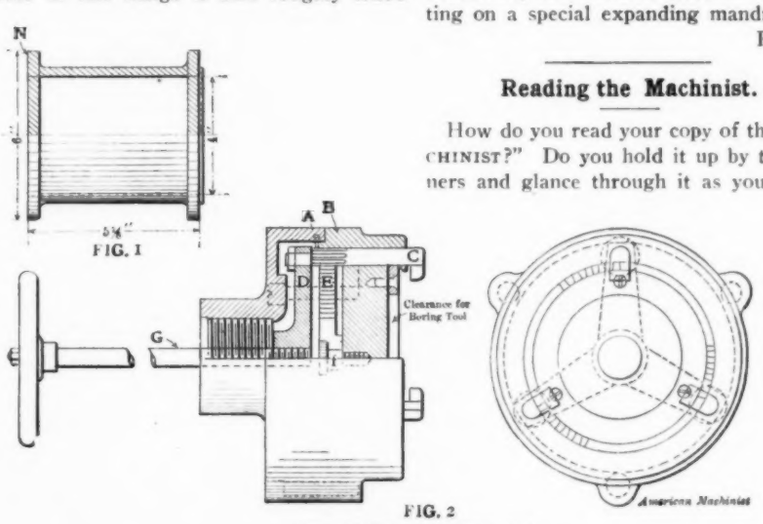


FIG. 2

THE WORK AND THE JIG.

up to give a good clamping surface for the hook bolts in the fixture, Fig. 2. This fixture screws on the lathe spindle, and is principally made of gray iron. *A* is a tight fit on *B* and securely clamped to it by three fillister-head screws as shown. A case-hardened ring forced into *B*—also held by three screws—forms the seat for clamping the cylinder to by means of the three pinion hook bolts *C*. These bolts are free to turn in the spider *D*, as the nuts on their ends shoulder against it. *E* is a wheel having a number of gear teeth cut in it the same pitch as the pinion-hook bolts. This wheel or gear is free to turn on the shoulder screw *F*, thereby controlling the movement of the three pinion-hook bolts. Thus when the operator moves a bolt the others move also. *A* is cored out the same shape as the spider *D*, with plenty of allowance for clearance and travel in either direction. *G* is threaded to fit the spider *D* and passes through the hollow spindle of the lathe. The clamping device is controlled by a hand-wheel on the end of *G*. These cylinders are very lightly clamped during boring and facing operations. After a number of them are bored they are finished-faced in one setting on a special expanding mandrel.

R. M.

Reading the Machinist.

How do you read your copy of the "MACHINIST?" Do you hold it up by the corners and glance through it as you would do with a daily paper, to try and discover if there is anything spicy and interesting or do you read it through carefully, *having an interest in everything you read?*

For my part when I get my "MACHINIST" on a Saturday I at once have a casual glance through it to take a general survey of the whole contents, keeping in mind those articles which are particularly interesting to me.

Then on Monday morning the first job I do *at the shop* (I am a draftsman) is to sit down and devour the "MACHINIST." First the articles which I have previously marked as interesting, after which I start with the first page of the advertisements, and continue right through to the last cover.

After I have done this I have a fairly good idea of what is contained in that particular copy, and many times I have found things cropping up during the week, which I remembered having read about in the "MACHINIST" on the previous Monday. I do not let this suffice, every few months I make it a practice to look through the back numbers, of which I have five volumes, so that my memory may be refreshed.

As regards the class of writing I like best, I really couldn't say, though I must confess, I generally read "Echoes from the Oil Country," Dixie's amusing experiences and all those bright, chatty little shop yarns which practically are of very little use, but which I wouldn't have left out at any price, as they give a lighter tone to the paper and make the mind more receptive for the solid meaty stuff.

Letters from Practical Men are always interesting because, even if not in our line, they should be interesting from the fact that they are written by fellow workmen in some part of the world, who have given their ideas to their fellows to benefit them and who are always extremely obliged if they find in the next issue that somebody has a much better idea for doing the same work. A man who finds himself in this position can always congratulate himself that if he had not set the ball rolling the later and perhaps better idea suggested by the other fellow might never have appeared. In fact, I think any idea, however crude, if there is any suggestion of novelty about it, ought to be sent in for publication, because there is no telling what it may bring forth in the shape of criticism from men who may have a better idea to offer or else an improvement to suggest in the original. Examples of this may be instanced in the articles on fractional indexing which appeared a year or two back —Tecumseh Swift's Chestnuts, I beg pardon, I mean Check nuts, etc., etc. It is unnecessary to mention further examples as there is always more or less of this sort of thing appearing every week.

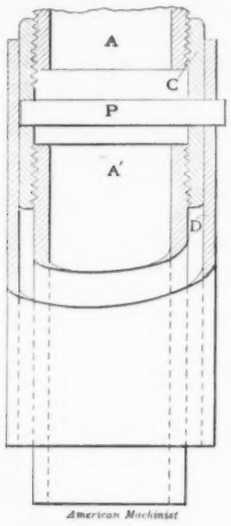
I only hope that the American Machinist will provide us with the same quality of reading in the future as in the past, and also that someone will suggest a better way than mine of soaking it in.

KONSTANT REEDER.

Yorkshire, England.

A Deep End-Milling Job.

By the breaking of a fitting A in a three inch pipe socket C, four hundred feet of two and a half inch pipe A^1 and our well drill were dropped four hundred and eighty feet from the surface. The socket C had a seven eighths inch pin P passing through it and projecting on one side. It



A DEEP END MILLING JOB.

was used to secure the casing D, but now it blocked the way so that no "grab" we had could pass it to pull out the four hundred feet of pipe and the drill. An old well drill was cut off, upset and machined into a rough end mill. As our well drilling rig was of the rotary type, the pin P was readily milled off leaving the pipe A1 open for the "grab" to get hold preparatory to removing the pipe and drill.

REPAIR SHOP.

An Inserted Tooth Countersink.

The countersink shown in the sketches will prove, I think, to be new to most of the readers of the AMERICAN MACHINIST. The idea for holding the teeth is not original with me, as they have made milling cutters that way for some length of time in this shop.

After running our largest turret lathe for some time on a new line of work, which has a 1½-inch hole to be countersunk to 2½ inches on the face of the work at angle of 90 degrees, we found that solid countersinks of that size cost too much to be practical to use, as they could only be reground about six times. To take the place of the solid ones I made two such as are shown in the illustration. Two were necessary, so that one could be kept sharp all the time.

The body *B* is of gray iron, the caps *C* of soft steel. The teeth are of Novo steel. The angle of countersink is 90 degrees, the angle of the bottom of the slots is 60 degrees. When the teeth have been ground down as far as practicable the screws are loosened and the teeth knocked down further in the slot, the difference in the angles making the teeth project as they are knocked down in the slots. The gray-iron-body I finished all over, except the angle. I then did some tall thinking as to how I was going to get the angle, as we have no lathe with a compound rest, and finally figured out the following way of doing it:

My lathe is equipped with a first-class taper attachment. The traverse feed and cross feed can both be thrown in at once so that they work together. When the traverse feed is thrown in, with the feed lever in position to make the carriage move toward the headstock, the cross feed is running in toward the center, and as both feeds are changed in direction by the same lever, that necessitated running the lathe backward and working on the back side of the work when turning the body *B*.

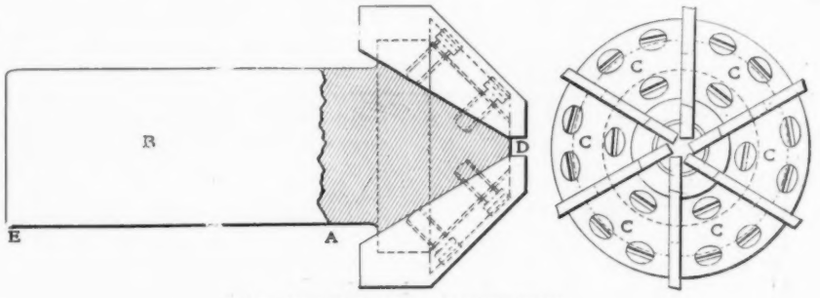
After taking several cuts I tried the angle and found it to be about 80 degrees. To get 90 degrees I connected the taper attachment, set it so that with the lathe running backward the carriage was feeding toward the tailstock and the tool on the back side of the work was feeding in toward the center, the taper attachment was pushing the tool in toward the center also, thus giving a more obtuse angle.

After taking off a few more cuts, trying the angle each time and varying the taper attachment, I soon got it so that it was turning 90 degrees in good style. The steel caps *C* were of course made in one piece. A forging was made with a straight extension on the small end to hold it by when boring.

The forging was grasped in the chuck by the extension and a ¾-inch hole drilled clear through; then the angle was bored with the carriage running toward the headstock, the tool running in toward the center—the taper attachment being set just the same and the lathe running forward. With a short, stiff boring tool, set the same height as the turning tool was on the body, no trouble was experienced in fitting the cap to the body. When the angle was finished a straight hole 13/16 inch diameter was bored through the extension. After removing the piece from the chuck it was driven onto an arbor and the angle-hole tested and found to run practically true. The outside of the cap was then turned to the same angle ¼ inch thick. The cap was then cut off from the extension and finished.

A hole was tapped at *D* in the body for a ⅜-inch screw and with a washer, which touched only on the cap, the cap was secured to the body. I then put the body in the lathe with the cap on and with a fine pointed tool marked off two lines upon which to lay off the screw holes. Having no index of any kind, I laid off the center lines for the slots in the lathe. The lead screw on the lathe has six threads to the inch, so I rigged up for one thread to the inch and by turning the screw one turn the spindle turned one-sixth of a turn. I then mounted a prick punch in the tool post on a height with the center at an angle of 90 degrees to the face of the cap. After turning the lead-screw around a few times to take out the back lash, I scribed a line on the collar on the lead screw and on the bearing which it bore against. Turning the screw around until the lines coincided I manipulated the carriage and cross slide until the point of the prick punch was right on the line at the small end of the cap, then a slight pressure left a dot through which to lay off the center line. Leaving the lathe at rest, the prick punch was moved over to the line on the large end of the cap and pressed in, then the screw was turned one turn, moving the countersink one-sixth of a turn, and so on until the cap was divided into six parts. I then laid off on the circular lines for the screws and was then ready for drilling and counterboring.

Removing the chuck from the shaper, I bolted the countersink to an angle iron strapped to the drill-press table, setting it at 45 degrees and drilling radially. The



AN INSERTED TOOTH COUNTERSINK.

body size drill was put in first just through the cap, the tap size next and then the counterbore. Two holes were drilled and then the cap was taken off, the holes tapped and the cap fastened on securely with the two screws. The rest of the holes were then drilled, tapped and all of the screws put in. The slots were cut in the shaper, as we have no milling machine; first roughed out with a tool $^{5}/_{32}$-inch wide, then all the screws tightened again before the $^{3}/_{16}$-inch finishing tool was put through. The caps and the body were then marked, no effort being made to get the caps so that they would interchange.

The last operation was to turn off $^{1}/_{16}$

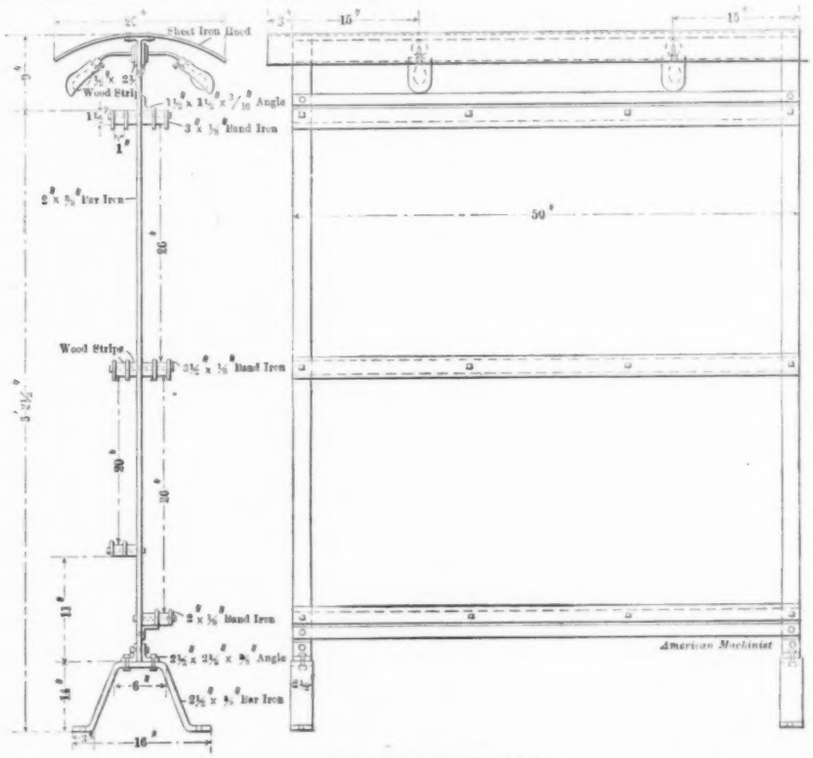
inch from the angle on the body, so that when the teeth were put into the slots, tightening down the screws in the caps tightened the teeth and held them securely. In grinding these countersinks I hold the end *E* of the body in the chuck, which has been turned up so as to run dead true, the outer end being supported by a rest at *A*. The head is set at an angle of 45 degrees. The tooth rest is stationary while backing off.

These countersinks are quite costly to make, but will have paid for themselves by the time they have been ground a dozen times. PAUL WESLEY.

A Shop Blue Print Rack.

The accompanying sketch illustrates a blue print rack which has proven a useful addition to the equipment of the erecting shop and it could no doubt be used in other departments with the same degree of usefulness.

The rack, as shown by the illustration, is made to receive sliding boards and on these boards the prints are mounted by tacks or glue. The different sizes of boards are made to suit the different standard sizes of drawings. At the top of the frame is a sheet iron reflector, extending the full length of the frame and ten inches over the side. Under



A SHOP BLUE PRINT RACK.

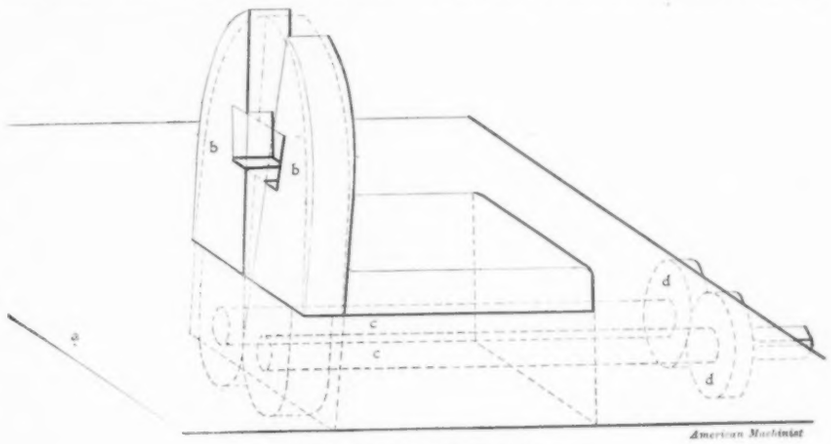
the reflector two sixteen candle power electric lights are placed on each side of the frame, which arrangement throws ample light on the prints for night work.

The frame, as a whole, may be made either portable or with legs for screwing to the floor as is shown by sketch. The slides proper are made of 1½ inch by 1 inch strips of wood with ⅛ inch band iron on either side to form grooves to receive the boards.

THOS. B. BURNITE.

A Novel Method of Coring.

The accompanying illustration shows something that I saw at one of the Worcester shops and which was a novelty to me. The problem which confronted them was to mold on a machine a piece which had a projecting lug with a core crosswise through the center. This would usually be solved by using a heel core but the way they have gotten around it is certainly ingenious. The pattern is located on to top of plate *a* as usual (the pattern being really quite different in shape from that shown on the horizontal leg), and the upright lug is split



A NOVEL METHOD OF CORING.

and shaped as shown by the dotted lines at *bb* and encloses a core of green sand in the center where the slot is to be. These half lugs project down into the part of the pattern within the stripping plate and are pivoted on two shafts, cc, which are geared together at slit by two spur gears, indicated by their pitch surfaces. One shaft carries a lever so that by turning it the two half lugs are spread apart enough to clear the core when being drawn and also force the sand out to the shape desired, as shown by the full lines. The whole thing, pattern, split lug and shafts are drawn down through the plate, leaving the core standing where it belongs. E. H. FISH.

A Taper Gage.

Contrary to Mr. Harrison's views, given at page 853, Vol. 28, Part 2, I was impressed with the idea that H. E. R. Manbrand had actually made the gage he described and had found it as others have, a most excellent and serviceable tool, or, being a practical man in charge of others equally practical, had recognized a good thing and wanted others to know about it. I have seen and used several such tools during the past ten or more years—varying somewhat in detail of course—and have found them to be just what Mr. Manbrand says they are.

One reason why men make such devices is because they do know about parabolas and the errors likely to creep into tapers, though not always ready with technical language in describing them. With the experience through which such knowledge has come they are enabled to ignore them, content in their ability to compensate for them in various ways by the use of a little of that gumption that deprives the scrap heap of many a really fine morsel.

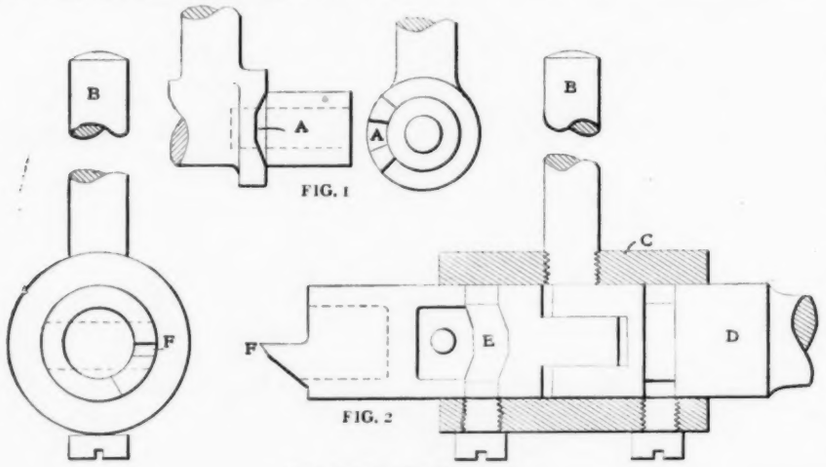
In case a taper should be large enough to rest upon the upper edges of the V-block, a good machinic will at once discover the tendency to rock, and do as others have done, namely, stone down the edges to a curve sufficient to offset that

of most tapers in common use. A very slight stoning is all that is necessary in a gage of the dimensions shown at page 708. Theoretically this would be open to objection, as two pieces of exactly the same degree of taper but of different length would appear to differ in angle if shorter than the V-block itself, but as it is only a gage of comparison, some judgment must be used in applying it. When it comes to that, the same can be said of a taper ring gage, the plug of which shows a convex surface after testing on the true surface plate in the usual way with a little Prussian blue. The first one of its kind I ever saw used was made about twelve years ago by a toolmaker named Jardine. In this the V-block was quite large, but as the blade was knife-edged no difficulty was experienced in sighting small work when held in the proper light. From the popularity of Mr. Jardine's gage I am forced to believe that instead of being consigned to the scrap heap, that of Mr. Manbrand has been made successful and economical use of by other men on the job, whose technical skill and accurate workmanship are never questioned.

H. B. B.

Hollow-Milling an Irregular Face.

It often becomes necessary to make special tools to expedite the production of small parts of machinery in manufacturing plants. Having over a thousand pieces to make as shown at Fig. 1, the tool—Fig. 2—was made to cut the "dip" (so called because of the motion of the



THE WORK AND THE TOOL.

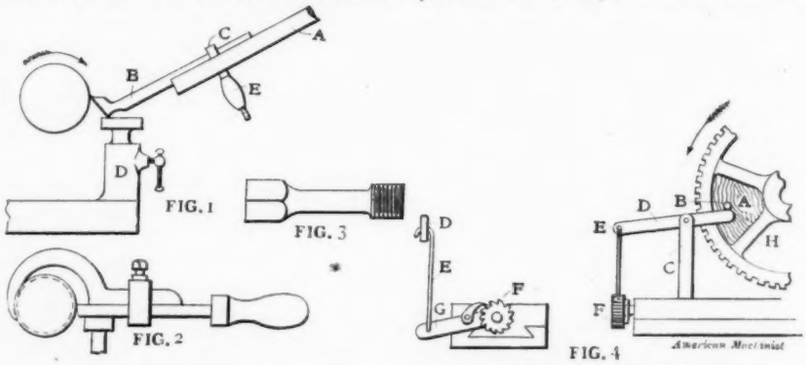
tool when running) in the shoulder of the piece.

The work was done on a turret machine, except the notch *A* in the shoulder, which was done with the tool, Fig. 2, used in an ordinary drill press. The handle *B* is held in a vertical slot so that the tool may be fed up and down by the movement of the spindle, but prevents sleeve C from turning. One screw in sleeve *C* runs in the continuous groove in the shank *D*, the other runs in a cam groove *E* which imparts the required motion to the cutting edge *F*.

I have found tools of this character—modified to suit the work to be done—to be very useful, and generally, cheaply and easily made. U. B. S.

Reminiscences of Shop Practice in the Fifties.

When I look at modern lathes, planers and other "get there quick" machine tools, the question suggests itself, how many modern tool hands can take an old hand lathe, hooktool, graver and chaser, and turn and chase a bolt or set screw, or turn and make a tap? While I have seen modern tools I have also passed through the hand tool period. When I went to my trade in an old railroad shop, there was only one screw-cutting lathe (a Chamberlain chain feed), in the shop. There were also two other chain feed lathes and three hand lathes.



HAND TURNING AND THREADING TOOLS—AN OLD POWER CROSS FEED

The hand lathes had hand feed slide rests. At that time most of the locomotives had copper tubes and copper tube sheets in the fire box. The fire box ends of the tubes were reinforced by cast iron bushings driven in. It was the work of us boys to turn these bushings (ferrules they were called) on one of the hand lathes using one of the hand feed slide rests. This was my first lathe work. Following this came turning and chasing patch bolts for the boiler makers, using the hook tool, graver and chaser; and the patch bolts came in by the kegful.

We turned, chased and nicked (or weakened) them at the wrench end so they could be broken after screwing in. Was it hard work? Well, it got to be by the time we struck the bottom of the keg. But turning patch bolts was fun compared to taking a piece of ¾ square bar steel and start in turning and chasing set screws. Worst of all was recutting a chaser on a dull hob. I recollect very well once when I was forcing a chaser up against an old hob until my eyes bugged out. One of the boys advised me to put some emery on the hob. No, I did not do it, knowing at the time what emery was for. That poor fellow and I served together in the Navy. He has since crossed the "divide."

What do I mean by "hook tool"? I don't know why they were called "hook" unless while turning the corners off a piece of work the point of the tool would hook into the work and the handle give the boy an unmerciful thump under his ear. Fig. 1 A is a wood handle about 1½ inches diameter and about 24 inches long. Along the top was a slot or groove to suit the size of steel. A bolt C passed through as shown and through the handle E in bottom end of which was a nut. The bolt being threaded it enabled the operator to draw the tool B down into the wood handle A. The tool had a heel or point on the bottom which bedded itself into the turning rest. We always had two of these tools, a round nose and a diamond point for getting in the corners, and starting threads. In handling the tool the operator would take hold of the handle E with his right hand and the long handle at A with his left hand, and bring the inside of his left forearm against his right hand and the handle E. This would give us control of the tool. Of course you had to step along on the turning rest as you carried the cut along. The tool would cut by giving the handle E the necessary twist which threw the cutting point of the tool along on the work. To smooth up the work to size we used a graver made of a piece of square steel or an old square file ground off at an angle and driven into a file handle; if it was a driving fit we sized the work with a file. In starting a thread we would use our diamond point and

watching the speed of the lathe strike a light cut about what we thought would be the number of threads wanted and then try and catch the thread with the chaser. In this we sometimes failed, as the thread in steel was very hard to catch. To prevent getting the work too small in our efforts to thread it we made a practice of leaving one end of the work enlarged like Fig. 3, which is a packing spring bolt for spring packing in locomotive pistons. This enlargement gave us a margin to work on. It was not an uncommon thing to get a drunk thread or have the thread stagger; to straighten up the thread we used a "doctor"—see Fig. 2. On top of the chaser we clamped the sickle-shaped tool C. The edge being sharp went into the bottom of the thread on the opposite side of the work, the chaser being in on the front side. The doctor would keep the chaser from wabbling and would get the thread quite straight. In turning brass the threading part was much easier, although I could never catch or start a thread with a chaser, always using the diamond point to start. For inside threads in brass work I used an inside thread tool in the slide rest by turning the feed screw fast or slow as the thread required. Most of our chucks for brass work were oak blocks bolted to the face-plate and bored out to suit, and the work driven in or held to the blocks by clamps and small lag screws. We had to improvise many ways for doing the work. Once in chasing 12 threads I was too quick and traced 6; noticing the mistake I tried again and again struck six; but it so happened I split the first six so that it looked like 12. My chaser took right hold of the work and I had a nice thread, but it would not go into the nut although it was the right size and 12 to the inch. I worked with it quite a while before the double thread explained the trouble. The planers we boys (and some of the men) used were hand power machines. The platen was moved back and forth by a crank at the side of the machine. A new machine came equipped with a balance wheel in place of the crank. It was something of an improvement, but still hard work. Both machines were hand feed. An old power planer came to the shop, but it was a rattletrap of very little use and very noisy. These old planers were soon followed by two good machines from the Industrial Works, Philadelphia.

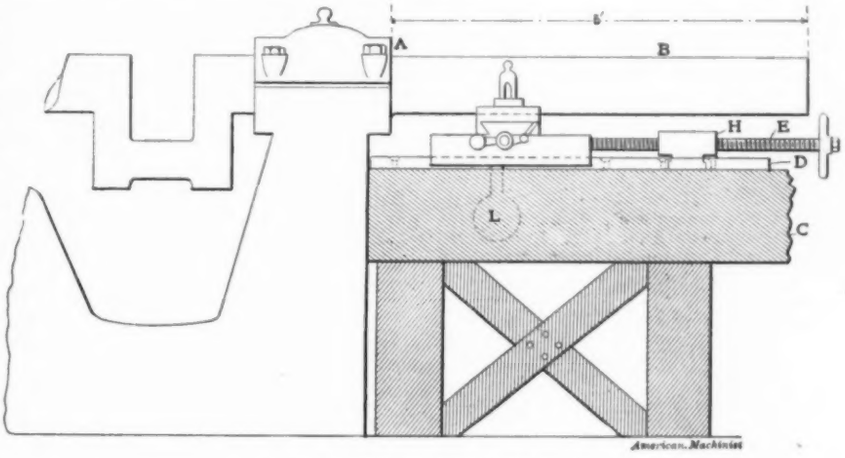
At that time all engine truck, tender and car wheels were keyed on the axles—there were no keyseaters—and the boys chipped the key ways in axles and wheels.

I don't know when power cross feeds were first introduced. But during my apprenticeship I ran an old screw feed lathe about 26 inches swing, the shears resting on blocks. At that time our locomotives were using spring packing and brass cylinder rings. It was this class of work I was doing. While facing the follower plates the idea of having the lathe do the feeding suggested itself. The large gear H next the cone had spokes in it. I fitted in between two of the spokes with a block of wood A, put into it the wood screw B, secured the bracket C to the lathe carriage, pivoted to the bracket the lever D. On the out board end of D was the wire hook E; the lower end of E passed through the end of the lever G in Fig. 4. The end of the cross feed screw being square, I fitted a ratchet wheel F; the ratchet wheel had a boss on the inside; on this boss was the end of the lever G. On the lever G was a pawl to engage the ratchet. When the lathe was running the wood screw would force down the lever D, Fig. 4, the back end raising would lift up the lever G and cause the pawl to turn the cross feed screw, which was left hand. When the wood screw passed the end of the lever the whole thing would drop back into position. It worked first rate and was kept in repair long after I graduated. Of course it would only feed one way and on work close to the face plate. This old lathe had no wheel to move the carriage along on the shears, the only way being to take hold of the outboard end of the cross feed screw. To adjust the feed for facing we threw out the feed gears, pushed or dragged the carriage close to the work, then threw in the nut, reached down and with both hands gripped the feed screw and turned it gently until the cut was the proper depth. With all this ceremony the old lathe did good work. Yes, it was an odd way of doing the work, but I would gladly go through it all again to be the happy boy that I was then. I forgot to say that the long handle of the hook tool rested on the operator's shoulder. Can any one antedate the old cross feed of 1857?

W. DE SANNO.

Truing a Crank Shaft in Place.

The duties connected with the position of machinist, "etcetera," in a wood-working concern are of a varied nature. This I soon discovered while holding such a position. I desire to treat here of one job which was quite a problem in its way. It consisted of truing the end of a crank shaft of a 150 horse-power gas engine on which a clutch pulley ran. The pulley having been neglected, had cut the shaft. There being no machine shop in the town, it would have been necessary to ship the shaft elsewhere had I not expressed the opinion that a first-class job could be done while the shaft remained in position. I was instructed to proceed with the work. The connecting rods were disconnected from the shaft—thus doing away with the compression. A small steam engine—used for lighting purposes—was belted up to the shaft on the end opposite the one which was to be turned. The shaft, as will be seen in the sketch, extended 5 feet past the engine bed. The portion to be turned lay between *A* and *B*, the diameter being formerly 6 inches. After removing the carriage from an 18 inch lathe, a platform *C* of heavy timber was constructed on either side of the shaft. This acted as a bed of a lathe. Two pieces of round, cold-rolled steel were obtained, and made as straight as possible. After scribing a line on the shaft—to roughly line up by—the cold rolled bars were fastened in position with wood screws, and acted as ways on which the carriage was moved parallel with the shaft. The carriage was placed on these improvised ways and held down by suspending a weight *L* from the center of it. The carriage was moved forward by a screw *E*, the end of which came in contact with the side of the carriage central with the ways. The other end of the screw was fitted with a hand wheel. The screw ran in a babbitt nut *H* fastened to the platform. There being some very hard spots in the shaft, the job was rendered much more difficult.



TRUING A CRANK SHAFT IN PLACE.

G. E. WHITE.

AMERICAN MACHINIST

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Systematic Testing of Files.

Perhaps it will be generally considered that this is rather a late day to be learning new things about files. Nevertheless we believe that the article published elsewhere in this issue contains things about these familiar and long-used tools which will be new to most users of them, and not only new but surprising as well; particularly those things which deal with the differences that have been found between the two sides of the same file, and between different files which are apparently alike and which might be expected to give practically the same service. In respect of efficiency, that is ability to remove metal, and also in the point of durability of the file itself, startling differences were found between the different files, and the conclusions drawn by the author regarding the different money values of different files are, to say the least of it, rather startling, and show that the mere first cost of a file is a matter of very small importance, compared with what the file will do when put into the workshop. The article, it seems to us, is an excellent example of the application of scientific methods of testing and comparison to a subject which has heretofore been judged entirely, or almost entirely, by empirical methods, and by the irregular and uncompared observations and notions of workmen, or of buyers of files.

Jet Propulsion Again.

Again the daily newspaper reporters have gotten hold of a revolutionary invention, in this case one which several times before has been declared to be about ready to revolutionize navigation. It has not yet done so, however, and we believe that builders of the present type of vessels are for a time secure. The present invention is the revival of jet propulsion, and in this case the inventor proposes to use gas or gasolene, which is going to explode in a cylinder, or cylinders, attached to a tube which is to extend longitudinally through the vessel below the water line, so that, by these rapid explosions, the water taken in at the front end of the tube will be expelled at the stern, and, as the inventor puts it, "the vessel will thus be propelled from shore to shore by what will be in effect a cable made of water."

It will be remembered that some years since a certain Doctor Jackson experimented with a vessel in New York harbor, made to be driven upon this principle, only he used ordinary pumps for forcing the water through the aforesaid tube, a point of his invention being the fact that he used very high pressure with a small jet, forcing the water out at high velocity, making the jet "as rigid as steel." Experiments made about that time at Stevens Institute showed not only that the plan of propelling vessels by a jet was not efficient, but that the most efficient form of jet was not a small one driving the water out at high velocity, but a large jet driving the water out at comparatively low velocity. It was also shown by these experiments that there was no difference whether the water when expelled from the stern of the vessel impinged against any other object or not; the same effect was produced when the water was simply expelled rearward into the air. The scheme has been tried many times, and we suppose will be tried many more, and each time anyone tries it he will be able to get some newspaper reporter to exploit his invention, as though it were an entirely new discovery.

An Advertisement Which Does not Say What It Means.

A friend who is the proprietor of a machinery building establishment sends us a leaf torn from an advertising pamphlet, in which a certain new tool is advertised, and in which it is declared regarding this tool that "inexperienced help can do better work and twice as much as the high-priced men." Our friend, referring to this, inquires: "What are we coming to?"

Supposing he wants an answer, and that others may be interested in the answer, we reply that, what we have already come to is the condition of having our advertisements written by men who make a specialty of writing advertising, and many of whom know nothing of the mechanical subjects to which their writing pertains. Most of them can probably write much better advertising than the practical mechanic can; but if with their skill in advertisement writing there could be combined a little more knowledge of mechanical operations, or if the advertisements, when written, could be carefully looked over and revised by mechanics who understand the subject about which the advertising is written, the result would, it seems to us, be generally a great deal better. What is probably meant in this case is that a man, though he may be inexperienced in doing the particular work it is intended for, will with this tool do better and cheaper work than the high-priced man can do by the older tools and methods; which, of course, is an entirely different thing, and a thing which is being done so frequently these days that mechanics are quite accustomed to it.

As to the Resignation of an Engineer.

At the time of the resignation of John F. Wallace as chief engineer of the Panama Canal, it was apparent that he was in some way, or by some influence, prevented from telling all that he knew and all that the public really ought to have known about his reasons for resigning. Much of this has come out, however, in his testimony before a committee of the United States Senate, and it seems to be

rather apparent from that testimony that some of our contemporaries, who were so ready to unqualifiedly condemn Mr. Wallace and to assert that his resignation as chief engineer of the Canal work was "unpatriotic," if not traitorous, ought to revise their opinions and make such amends to Mr. Wallace as may be possible. It was not, in fact, fairly reasonable to suppose that a man of Mr. Wallace's character and standing would resign at the time and in the manner he did, without having some pretty good reasons for doing so; and we think it would at least have been in much better taste had some of his critics perceived the propriety of suspending judgment in the matter, and of not coming to a decision upon the one-sided and entirely unsupported accusations, if not abuse, given out by Secretary Taft.

To sum up the whole matter, it seems that Mr. Wallace resigned because the conditions were made such that it was impossible for him to accomplish the work he was put there to do, and whenever such a condition arises, any self-respecting engineer who is in the habit of doing things, will at once resign if he has the right to do so, and he should always reserve such right, to be exercised when such conditions arise. Mr. Wallace's testimony amounts practically to a demonstration of what has been our belief from the beginning: that is, that there were the best of reasons for his resigning.

A Swindle Exposed by the Government.

A particularly despicable form of swindling has been exposed by the Department of Agriculture, which swindling is done by means of adulterated seeds, particularly of grass and similar seeds. It seems that large quantities of cheap seeds bearing a resemblance to certain well-known grass seeds produced here are imported for the purpose of adulterating such seeds, and that a farmer who has gone to the trouble and expense of fertilizing and otherwise preparing a piece of ground for a certain seed, may, unless he looks out for it, be sold seed which is adulterated to the extent of 98 per cent.; though this is extreme and most of the adulterations are not so great. The best part of the present exposé is that the names and addresses of the firms selling these swindling mixtures are not only given by the Government publications, but are given out for publication in the daily press, and we find in one of the New York papers a large list of such names and addresses; thus not only enabling buyers to protect themselves, but acting of course as a powerful deterrent in the matter of such swindling in the future.

The Government seems to have the industry and business of agriculture particularly under its protection, and to do more of such work for agriculturists than for men engaged in any other line of business. If it ever undertakes to make investigations regarding the adulteration of lubricating oils or of alloys, or any of the things used by machinery manufacturers, and will give out the names of manufacturers or dealers handling such adulterated things, we will engage beforehand to publish such names and addresses, and hope we will be given the opportunity of doing it.

Technical Overtraining in Germany.*

Consul Harris, of Mannheim, Germany, says the German Empire is rapidly building up a class of men for whom it has no employment at fair wages, and for whom the demand does not increase as fast as the supply. He cites the opinion of a writer in a leading paper of Mannheim to the effect that technical education in the Empire has been carried far beyond the power to utilize it. The consul writes:

The question of erecting a school for the building trades in Mannheim being at present under discussion, a prominent constructing engineer has contributed an article to a leading newspaper of the city, in which he aims to show that technical education in Germany has gone beyond actual needs. He contrasts the number of those taking such training with the number in other professions, and concludes that the ranks of the technically trained are at present much overcrowded. The following extracts from his article will be of interest. The term "technical high school" used in the article is peculiar to the German school system, and represents the highest grade of technical schools in Germany, of which there are at present ten in the Empire.

NUMBER OF STUDENTS.

The number of those studying in the technical high schools in Germany in the winter of 1890-91 was 5432 and in the winter of 1904-5 15,866, or, in other words, there was an increase of about 200 per cent. On the other hand, the number studying theology in Prussia in the winter of 1887-88 was 2713, and in the winter of 1903-4 1005, or a falling off of almost one-third. The number of medical students in Prussia in the summer of 1887 was 5168 and in the winter of 1903-4 3020, a falling off of almost one-half. In the scientific technical branches of the departments of philosophy in the advanced schools (as the universities), which, as shown by experience, prepare a large percentage of technically trained students, the number of such students in the winter of 1901-2 was 1100, and in the winter of 1903-4, 3015. It thus appears that there is a rapid increase in the technically trained that casts into the shade the well-known enormous increase in those trained in legal studies, which in 1889-90 amounted to 2925, and in 1903-4 to 6345. From the latter ranks also, it is not to be overlooked, come many of those holding official positions in industrial undertakings.

CONDITIONS IN MIDDLE-CLASS SCHOOLS.

Similar conditions are to be noted in the middle and lower technical schools. Thus, in the 22 schools for the building trades belonging to or receiving aid from Prussia, the number of students in the winter of 1902-3 was 4251 and in the winter of 1903-4 was 5077, an increase of 20 per cent. in a single year. For a period of ten years this increase would amount to 200 per cent. The number of special schools in the metal industries belonging to or supported by Prussia in 1891 was 9; in the winter of 1903-4 it was 19, an increase of 110 per cent. The number of students in attendance in 1891 was 755 and in the winter of 1903-4 it was 3010, an increase of 300 per cent. This number is equaled, if not exceeded, by those attending private technical schools. In Saxony, which plays almost the part of an incubator of middle-grade technical students, the number of schools for machine construction in 1884 was 2, with 524 students. In 1902 there were 6 schools, with 2687 pupils, an increase of 200 per cent. in schools and 410 per cent. in pupils. The number of schools for the building trades in 1885 was 5, with 469 pupils, and in 1902 it was 10, with 1342 pupils, or an increase of 100 per cent. in schools and 185 per cent. in pupils.

EFFECT UPON WAGES.

It is apparent that the increase in numbers in the technical ranks has gone far beyond the demand—200 per cent. against about 50 per cent. on the average. The consequence of this overproduction in technical resources is a constantly diminishing rate of wages, as the law of supply and demand applies here as elsewhere. Wage statistics, which were compiled from inquiries made of 20,000 members of the German technical association, and which were presented in the Reichstag by Dr. Heinz Potthoff, a member, show the following picture: Almost one-fourth of all city and other trained appointees receive a salary under 1800 marks ($428.40) per year, 35 per cent. receive from 1800 to 2400 marks ($428.40 to $571.20), only 24 per cent. receive from 2400 to 3000 marks ($571.20 to $714), and only 19 per cent. receive over 3000 marks ($714). It is to be noted that among those considered were a large number of office men who are engaged with public officials, which gives to the total a more favorable aspect, because among officials so employed a rate of salary from 2100 marks ($499.80) to 2700 marks ($642.60) generally prevails.

From all this it appears that for an increase of technical resources and schools there is at present no pressing demand. There is an increased and, as it were, artificially created proletariat, and the various industries are not in a position to pay for these superfluous powers.

*From Daily Consular and Trade Reports.

New Tools and Machine Shop Appliances.

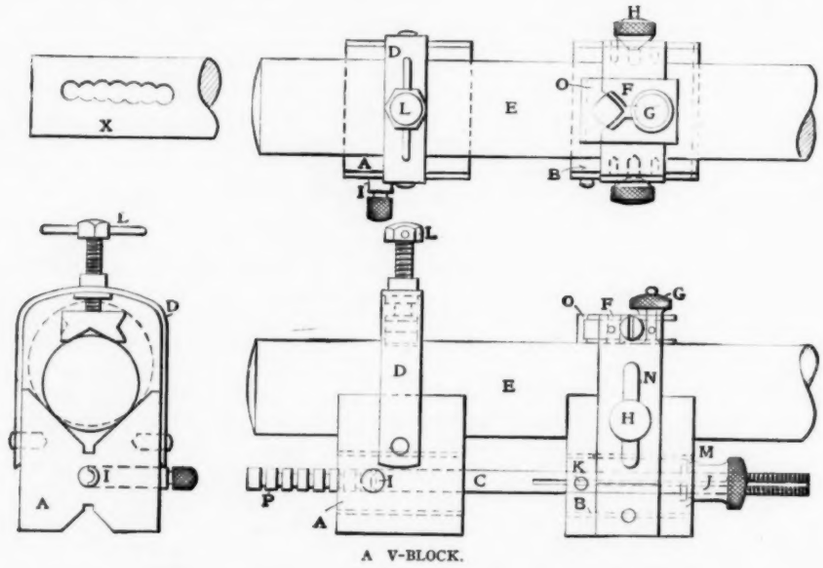
A V-BLOCK.

The illustration shows a V-block for spacing holes to be drilled in cylindrical and other shapes. A patent has been recently granted for this device to R. Blazej, Whitestone, Long Island.

The work *E*, is clamped securely in the V-block *A* by the screw *L* at the top of the yoke *D*. The yoke *D* can be swung so that the small V is on top for operating on small work. The V-block *B* carries the adjustable yoke *N* to which is fitted the adjustable drill guide composed of two members, *O* and *F*. The work *E* rests in the V-block *B* but is not clamped to it in any way.

The V-block *B* is, however, connected with the V-block *A* by means of the rod *C*. The rod *C* has a series of rectangular grooves *P*, spaced ¼ inch apart—for coarse spacing—cut in one end of it. These grooves engage with a clutch-pin *I*, which locks the rod *C* in any desired position endways.

The other end of *C* is threaded, 16 threads to the inch. The rod *C* is splined at the threaded end to keep it from turning in the V-block *B*, through a hole in which passes. The screw *K* in the V-block *B* slides in the spline in the rod *C*. The nut *J* is secured to the V-block *B* by the plate *M*, a shoulder at the back of *M* preventing it from falling out. The nut *J* is graduated into eight parts. This, in conjunction with the 16 threads per inch on the rod *C*, permits an end movement of 1/128 inch, which is quite close enough for a tool of this class. The adjustable bushing *O F* is quasi-rectangular in shape. It is composed of two hardened plates *O* and *F*, the former under the latter. These are locked by the screw *G* to the desired size to suit the drill. The inventor states that while the bushing *O F* is not exactly mechanical in appearance, it does the work, and is less expensive to make than a series of bushings. At *X* is shown a piece of work done on the device.



A V-BLOCK.

TEST INDICATOR.

This indicator, which is for general shop use, is known as the "Triumph" and consists of a swiveling body mounted at the end of a shank for the tool-post and provided, as shown in the line cut, with a hemispherical seat forming the female member of a ball-and-socket joint for head *A*, the latter being shaped, as will be noticed, for both outside and inside work, and carrying also a point for centering work. Rod *B*, extending from the rear of head *A*, passes through a loop at the rear end of pointer *C*, this pointer being carried by pivoting screw *D*, and its front end passing over the graduated plate *E*. The rear end of rod *B* is drilled out and split to form a socket and in centering work the loop at the end of pointer *C* is swung up out of the way and an auxiliary needle placed in the socket, thus nearly doubling the length of rod *B*, and multiplying considerably any movement of the contacting point in head *A*. The regular indicator pointer *C* shows about 15 to 1 any inaccuracy in the running piece being tested. The indicator is made by G. G. Riggs and A. E. Babin, Waterbury, Conn.

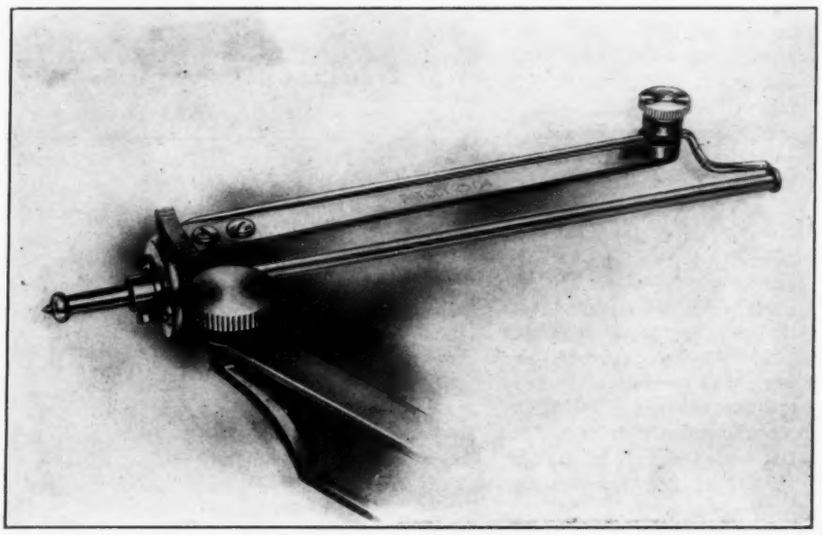


FIG. 1. TEST INDICATOR.

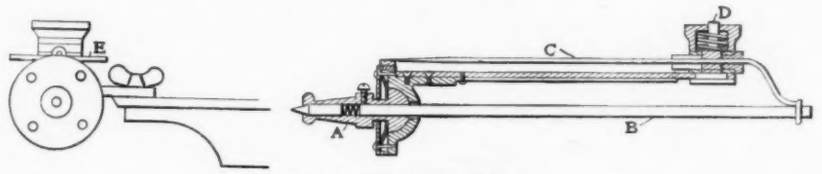


FIG. 2. TEST INDICATOR.

The recent collision caused by a drunken engineer has moved the Prussian Minister of Public Works to issue an order which positively forbids the use of intoxicating drinks while on duty and imposes severe penalties for its violation. The manner in which the temperance movement has spread on the German railroads is notable. But a few years ago the few men who advocated it were looked upon as cranks, and their efforts seemed to be rather discouraged than otherwise by the authorities; now the tendency is all in the other direction, and apparently a trainman known to be a total abstainer will have the preference, and the one who is known to tipple a little will find it hard to keep his place, to say nothing of getting promotion.—*Railroad Gazette.*

Frederick T. Towne.

Frederick Tallmadge Towne, whose death we briefly anounced last week and which occurred at Stamford, Conn., February 4, was born at that place March 5, 1872. He early developed a taste for mechanics, and upon graduating from the Massachusetts Institute of Technology, started work at once in the Yale & Towne factory at Stamford doing practical work in the various departments and becoming acquainted with the details of the operations performed therein. About six years ago he became general superintendent of the works. It was his constant desire that the establishment should become a model manufactory not alone in the character of its products but in its general organization

FREDERICK T. TOWNE.

and the opportunities offered its employees. At the time he was stricken with the fatal attack of Bright's disease, he had just completed an address to the entire force of employees, who were gathered in the foundry, the occasion being the semi-annual award of prizes for suggestions for improvement of conditions at the works. Mr. Towne was a former president of the National Founders' Association, having been elected to that office in 1902; a member of the American Society of Mechanical Engineers and a member of the Engineers' Club. He was president of the Stamford Manufacturers' Association at the time of his death, and also a member of the Board of Appropriations of the city government. He was a vestryman in St. Johns' church, and assisted in the establishment of night schools for boys. Classes were organized under his direction, the company furnishing the meeting-room for the students and providing competent instructors.

Mr. Towne was very popular with the employees of the company, and was frequently a guest at their gatherings. The universal esteem with which he was regarded was manifested upon the afternoon of his burial by the suspension of operations in practically all of the local factories. The remains were escorted to Woodland cemetery by fifteen hundred workmen.

Mr. Towne had been a member of the A. S. M. E. since 1895, having joined at this time as junior member, and been made a member in 1902. He leaves a widow and two children.

Echoes from the Oil Country—Getting the Capacity of an Irregular Shaped Tank.

Tank does not seem to be exactly the term to use to describe this irregular shaped vessel which looks as though some one had started to build a boiler and had changed his mind. The body is of varying diameters, and the heads look as though they might have been intended for tank-car tanks. Perhaps the original builder had been in the tank and boiler business and had used the left overs and the culls, and had helped out a little where they did not come together, and this was the result.

Any one who tries to account, in a logical way, for all the things that he sees will never be without occupation for his spare time; no, not even if all his time is spare. I am not going to account for the shape of this vessel, nor for the way it chanced to be where it is, nor for the many uses it has been put to. It may have had various names in the course of its travels, and these would likely vary with the use it chanced to be put to. Now it is known as a tank, with various prefixes.

It so happened that the owner wanted to know the capacity of this tank one day and told his mechanical engineer to get it for him. It is not a pleasant thing to have a man in authority want to know such a thing about such an object as that tank, but Jones took his steel tape and went to measure. The man who helped to do the measuring was filled with wonder to find that anyone had education enough to figure out such a thing.

"If you have much of this kind of work to do I don't envy you your job," said he, wanting to be friendly.

"This is a very simple thing." said Jones, with the air of a man who felt rather offended because he had been put on such simple work, "and the worst part of it is getting the measurements out here in the dirt and cold." "I'll do anything I can in the way of seeing that you get all of the measurements you want, but when you get to the figuring I am not in it."

Jones was somewhat of a new man about the works, and Pete, who was a sort of handy man, or man of all sorts of odd jobs, wanted to do his best to get on a friendly footing.

By and by another man was measuring the tank. Not wishing to be personal I will call him Smith. Pete again helped. He said nothing about having helped the other man, although he did his best to be obliging with this one. Pete had long ago found out that it does not pay to know too much about the business of others, but this measuring set him to thinking.

When Jones had taken his figured result to the manager, who may be called Brown for purposes of identification, that worthy wanted to know how he had gotten it. When he saw the array of figures he said: "This happens to be a case where I want close results. Please go over the matter carefully again."

Then Smith was called without Jones knowing anything about it, or Smith knowing that Jones was on the job.

The second result produced by Jones differed quite a bit from his first one.

"You are sure that this is the capacity of the tank are you?" Brown asked.

"Yes sir. You will find that is very close. Owing to the extreme irregularity of the tank it may not be absolutely correct, but it is well within any practical requirements."

When Smith produced his results he was also sure that they were right, but as they did not agree with the figures that had been received from Jones, Brown referred the matter back to each of them. He then took a walk down to where the tank sat. Pete was at work near by.

"Pete, how much do you think that tank will hold?" he inquired

"I would guess that it holds about a hundred barrels, but if I wanted to know for sure I would measure it," said Pete.

"How would you measure it."

"I would just get the hose and stick it in the top and while the water was running in I would get an empty oil barrel and take out one head and put the bung in, and then I would measure forty-two gallons into it while it set on the scales. That would let me get the weight too, and if it didn't come out right I would measure it over again. Then I would make a mark around the barrel to show where the water came to. When I got the tank full all I'd have to do would be to draw it out into the barrel, and when the barrel was full up to the mark over she'd go, and I'd fill her up again.

"I would put down a mark for every time I got the barrel full."

"Do you think you could stop the water just at the mark every time?"

"I'd do the best I could, and I'd have a pail and an old can here. If I didn't get enough into the barrel I could put it in from the pail and if I got too much in I would dip some out into the pail. I think I could stop close enough for that. If I couldn't I would get another pail."

"Go ahead and do it in the way you

say, and do it carefully, and bring me your measurements as soon as you get them."

In the course of time Pete's results were on Mr. Brown's desk along with those of Jones and Smith, and they did not agree with either of the others.

Mr. Brown sent for Jones and Smith.

"Gentlemen, there is something wrong with your statements as to the capacity of that tank. If you were both right your results would be the same but they are not. I am inclined to think that you are both wrong."

"I was exceedingly careful in taking my measurements, and used the very best formulas," declared Jones.

"I used extreme care and made due allowance for every departure in the workmanship from the true curves, and carried my computations out to the—" Smith was very earnest.

Brown interrupted. "Gentlemen, I have no time or desire to go into the details of the matter. That part is for you. I do not care how this work is done so that it is accurate, and done at a reasonable cost. Go and work together, and when you get a result which you know to be right let me have it."

It is hard to surrender a point when you know that you are right, and that tank was a beastly shape. The result finally arrived at might be called a voluntarily arbitrated result. Neither of the men believed it to be as near right as *his* result obtained while working alone, but each one thought it to be nearer than the other fellow's.

When this result was taken to Mr. Brown he shook his head. "Wrong again. Here is the capacity of the tank" and he produced Pete's figures. "It cost about two dollars to get them and I believe they are right. You men have done a lot of hard work and it has cost several times that and it does not amount to anything."

"How did you get that result?" It was as if Jones and Smith were speaking a piece together.

"I had Pete fill the tank, and then run it out into a measured barrel. Either of you could have done that. You could have measured the water into the barrel yourselves if you wanted to; and noted the temperature; and put on any other refinement you thought best. It would have cut out the large element of guess work which your methods made necessary.

"I do not know how closely Pete worked in doing his work, but I have lots more faith in his methods than I have in yours. The chances for mistakes are very few. While we are at it I want you to go and fill his barrel to the marks he puts on and see how many gallons you make it. Don't forget in doing your work here that it is results, and results only that the company is able to pay for."

Pete's gage of that tank still stands

There isn't any moral in this unless it is to see that all tanks are made of regular shapes or else that all irregularly shaped ones are put to uses where their capacity does not have to be known.

Figuring often saves a lot of hard work, and work often saves a lot of hard figuring.

W. OSBORNE.

The Central of New Jersey's School for Apprentices.

The Central Railroad of New Jersey recently has established at its shops at Elizabethport, N. J., a school for blacksmith, carpenter, machinist and patternmakers' apprentices, which promises to be of great benefit to the company in future years by raising the standard of technical education of the employees who will have part in designing and constructing the railroad's motive power. The school has been evolved by E. G. Van Doren, superintendent of shops, and B. P. Flory, mechanical engineer, acting under the direction of William McIntosh, superintendent of motive power

As a result of an investigation of various schools now in existence, it was decided to divide the school into three classes, which are held during working hours: A Monday class for apprentices who have some experience in drawing and who have some working knowledge of arithmetic, etc.; a Wednesday class for apprentices who have had less experience in drawing, and a Friday class for those who have had no instruction of this sort. The organization of this school has been accomplished by a ruling that all boys applying for positions as apprentices shall pass an examination in the elementary studies of reading, writing, and arithmetic and shall present three letters of introduction from business men in the community in which they reside testifying to their moral character. No apprentice shall be accepted who is under 17 years of age. The duty of passing upon the eligibility of boys seeking positions as apprentices has been placed, so far as education is concerned, in the hands of the instructor of the apprentices' school, who is George W. Rink, chief draftsman of the motive power department.

All of the apprentices at Elizabethport are required to enter the school and to continue therein during the four years of their apprenticeship. This undertaking involves instruction of two hours a week for each class, and the class hours are from 12:45 to 2:45 p. m., on the three days mentioned. The company has fitted up a schoolroom in its storehouse building and has supplied this with tables, benches and blackboards and all of the necessary drawing boards, T-squares and other supplies, excepting the drawing instruments, scales and triangles. The method of instruction followed by Mr. Rink has been evolved as the result of a decision that while the work must include theoretical teaching, it must at the same time be eminently practical. For this reason textbooks are dispensed with, but typewritten instruction sheets, in blueprint form, based upon textbook theories in the elements of mechanical drawing, are distributed among the students as a basis of study in connection with the practical work placed before them.

The purpose is to give the apprentices a thorough understanding of the use of the tools and of the meaning of the various lines shown in the blueprints. It is the opinion of Mr. McIntosh, superintendent of motive power, and of his assistants, that a knowledge of drawing is a prime requisite to the results which it is hoped to obtain by the establishment of this school. Heretofore a large percentage of the men who have served their apprenticeship have had an inadequate knowledge of the essential principles of the drawings from which they work, and it is hoped that when the new school has been in operation for a time that at least this proportion will have a thoroughly intelligent comprehension of these fundamentals. The members of the class are required to draw from models and castings. They are put to work at first to draw from the wood blocks of various shapes in order to acquire a facility in representing objects and dimensions on the paper, and this is followed by more advanced training.

A feature of the work, and one which was considered in connection with the decision to do without textbooks, is the plan of making the instruction so far as practicable fit the individual needs of each student. It is aimed to give each apprentice special help in the branches in which he is deficient and to provide more advanced work for those students who devote much more time at home to the work given them. The road has now 60 apprentices at Elizabethport, all of whom are receiving the instruction here outlined. It is believed that the company will profit greatly by this departure and that it will prove to be well worth the two hours a week out of the time of each apprentice. The instruction, also, will be of immediate profit to the students after they have served their apprenticeship, for under the present plan much time is wasted by reason of the fact that many of them are under the necesity of troubling their foreman about matters with which they will themselves hereafter have a more thorough acquaintance.—*The Railway Age.*

When Edison's phonograph was exhibited before the French Academy, the Member Bouiland rushed upon the exhibitor. Seizing him by the collar he shouted, "Wretch! we are not to be made dupes of by a ventriloquist."—*Modern Machinery.*

New Publications.

"Electric Wiring Diagrams and Switchboards." By Newton Harrison, 272 5x7½ inch pages with 105 illustrations. The Norman W. Henley Publishing Company, New York, price $1.50.

This book is a logical presentation of the practice of electric wiring, together with enough of the theory to make the explanations intelligible and to avoid rule-of-thumb work. While small, the book contains a large amount of well arranged and well presented material and it can be recommended to those who wish to understand principles as well as practice.

"Machine Shop Arithmetic," Fourth Edition. By Fred H. Colvin and Walter Lee Cheny; 144 4x6-inch pages. The Derry-Collard Company, New York. Price 50 cents.

That this excellent little manual of shop calculations has met a real demand is obvious from the call for another edition. Additions to this edition include metric threads, together with force, shrink and running fits.

"Mechanics for Engineers." By Arthur Morley. 282 5x7-inch pages, with 199 illustrations. Longmans, Green & Co., London, New York and Bombay.

This is a compact general treatise on Mechanics without the use of the calculus. It discusses motion, work, power, energy, statics, center of gravity and moments of inertia, and concludes with a chapter on the elements of graphical statics. Knowledge of algebra, elementary trigonometry and curve plotting on the part of the reader is assumed. The English gravitational system of units is used throughout, the metric and absolute systems being explained but not used. The book is bound in the superior manner characteristic of English books, which we wish our publishers would more generally copy.

"Die Luftpumpen, Projektierung, Berechnung und Untersuchung der Kompressoren und Vakuumpumpen. Ein Handbuch fuer die Praxis." By Dipl. Eng. M. Hirsch. Two volumes, 7¾x11¼ inches, the first containing 95 pages and 96 figures, the second 93 diagrams. Gebruedder Jaenecke, Osterstrasse, Hanover, Germany. Price in pamphlet form, 8 marks; bound, 9 marks.

Air pumps—which term is used to comprehend air compressors and vacuum pumps—are the theme of the book before us. The title, as it is above given in full, should go far toward explaining the nature of this book which, it may be said, is a work of decidedly solid appearance. The author explains that the formulas of the mechanical theory of heat are assumed as a basis, so that the treatise is primarily intended for the special engineer.

"Jahrbuch der Automobil-and Motorboot Industrie. Im Auftrage des deutschen Automobil-Verbandes." Herausgegegeben von Ernst Neuberg, Civilingenieur. Second year. 526 7½x9¼ inch pages, with 867 figures in the text, etc. Boll & Pickardt, Georgenstr. 23, Berlin, N. W. 7.

This year book ought to prove of great interest to the German-reading persons who like automobiles and motor boats, particularly as regards their technical features. The copious and varied contents comprise articles on fuels, internal combustion motors, electric and steam vehicles, automobile lighting, machine tools used in manufacture, bodies, power application, motor bicycles, motor boats, air ships, legislation, etc. There is a digest of German, Austrian, English and American patents, there are citations to periodcal literature, statistics of Berlin accidents, notices of events, etc. This second annual volume appeared about the middle of 1905 and a new one is presumably in preparation, but to judge from the contents, which are of more or less permanent value, each succeeding volume should comprise altogether or chiefly new matter. The volume is well printed and bound. A hotel guide is inserted in separate pamphlet form.

Personal.

Our contributor A. L. DeLeeuw, who was for some years chief engineer of the Niles Tool Works, at Hamilton, Ohio, and who resigned that position some time ago, has opened an office as consulting engineer in the Rentschler Building, Hamilton, and reports that he has been quite busy in getting up designs of special machines and in advising on the arrangement and equipment of machine shops, especially for railroad work.

Sheldon E. Bent, who has been located in Mexico for the past six or seven years as superintendent of transportation of the Inter-Oceanic Railway of Mexico, and as general superintendent of the Vera Cruz & Pacific Railroad, is now connected with the track department of the Railroad Appliances Company, of Chicago, Ill. Mr. Bent, previous to his connections in Mexico, was at one time superintendent and then purchasing agent of what is now a part of the Brooklyn Rapid Transit system.

Obituary.

Isaac Kinnear, for fifty years an engineer of the Lancaster, Pa., fire department, died recently at his home at the age of sixty-nine.

Dr. J. B. Littlewood, of Illinois, chief of the Division of Chemistry in the Patent Office in Washington, died February 7 from heart disease.

Bradford L. Crocker, treasurer of the Washington Mills Emery Manufacturing Company, of North Grafton, Mass., died recently at the Massachusetts General Hospital, at Boston.

Jerry B. Holt, one of the oldest and most respected citizens of Forestville, Conn., and some years ago connected with the old E. N. Welch Clock Co. of that place, died February 3 of cancer of the stomach, aged 80 years.

George Atkins, years ago a resident of Bristol, Conn., and later located in Indianapolis, Ind., where he was connected with the Atkins Saw Company, died recently at Pomono, Cal., 85 years old.

Col. Solon W. Stocking, a member of the board of examiners-in-chief of the United States Patent Office, died at Washington, D. C., February 8, of cancer of the throat. He was 70 years old and went to the Patent Office in September, 1869.

Arthur Smith, superintendent of the American Horseshoe Company's plant at Phillipsburg, N. J., died recently in New York City after an illness of a week. Mr. Smith was a resident of Easton, Pa., and was on a visit to New York when taken ill.

William F. Nisbet, a well-known New York City resident, who some years ago was connected with the Architectural Iron Works and later became an extensive traveler and art collector, died February 5 at his home on West End avenue, of apoplexy, aged 71 years.

Samuel Haggerty, Sr., a noted bronze molder, died suddenly of apoplexy, February 3, at West 127th street, New York City. Mr. Haggerty worked upon the Capitol at Washington and made some of the mountings for the bronze railings in Central Park, and Hyde Park, London. He was connected with the firm of James & Kirkland, brass founders.

William H. Mead, an octogenarian, who for many years lived on the royalties from his inventions, was found dead, February 4, in a hotel on Park Row, New York City, in a room which he had occupied for over twenty years. In his room were found many drawings relating to gas appliances, and a large number of models of gas burners, heaters and similar devices invented and constructed by him.

Ezra Sawyer, an inventor and manufacturer, died recently at Worcester, Mass., where he had resided for many years. He was born in 1815 at Boylston, Mass., and as a young man worked at loom fixing, afterward taking up pattern making, which trade he followed for a long period at various shops in Worcester. One of his inventions was a metal separator which he manufactured up to the time of his death.

Robert D. Bryce, almost the last of the pioneers of the flint glass industry, died February 7 at Ingram, Pa. Mr. Bryce was born at Pittsburg in 1821. He learned the glass business in the factory of Bakewell, Page & Bakewell, which was the first factory west of Boston. In 1850 Mr. Bryce founded the firm of Bryce, McKee & Co., which afterward, under the name of Bryce Bros., was taken over by the United States Glass Company.

Andrew J. Broughel, Sr., one of the best known railroad men in New England, died February 4 at his home in Hartford, Conn., of pneumonia after an illness of two days. He was born in Dublin, Ireland, seventy years ago, came to Hartford in 1863 and went to work in the machinery department of the "Consolidated" railroad. He was afterward foreman of the machinery department of the Old Connecticut Western railroad and master mechanic of the Hartford & Connecticut Western, the Air Line-Northampton division of the New York, New Haven & Hartford, and the St. Joseph & Grand Island division of the Union Pacific. He retired from active railroading in 1895. He was considered in railroad circles an expert mechanic in the handling and construction of locomotives and leaves a record in the various positions he held second to none.

A special form of Sturtevant gas exhauster known as a "Gas Booster" is now made for locally increasing the pressure of gas to meet special requirements, as for gas furnaces, brazing tools or laundry mangles; or for localities where the consumption has outgrown the capacity of the pipes, or in hilly towns where low lying districts fail to get sufficient pressure, or to overcome the resistance due to frost in the pipes. A gas burner supplied by this device, even though connected close to the outlet of the exhauster, will, it is stated, give a perfectly steady light. The device is made by the B. F. Sturtevant Company, Boston, Mass.

An alloy having a nickel base has been recommended as the best material for valves for superheated steam; copper is quite unsuitable for this purpose, as it rapidly becomes weaker at temperatures beyond 400 degrees Fahr.

Business Items.

The well known company of Pedrick & Ayer, formerly of Philadelphia, now located at Plainfield, N. J., has been purchased, and will hereafter be operated by the Railway Appliances Company, of Chicago, Ill.

The Sprague Electric Company, New York, is making a specialty of motor equipments, for driving heating and ventilating apparatus, and among recent orders for such equipments are the following: The First Day and Night Bank, 5th Ave. and 44th Street, the Knickerbocker Hotel, the Broad Exchange Building, the New Women's Hospital, all in New York, and also the Hoboken Terminal of the D. L. & W. Railroad.

The Chandler & Farquhar Co., Boston, Mass., dealers in machine tools and machinists' supplies, state that they are very busy and the past month has been the best January business they have ever had. They intend to exhibit at the Boston Automobile Show, March 10-17, and will have 1000 square feet of space. They will show a complete line of tools and sundries and their showing will include the new Chandler Planer, of Ayer, Mass., the Coates line of Flexible Shaft Transmission. Norton Emery Wheel Co.'s line, Card Taps, Jacobs Chucks and other shop equipment.

Manufacturers.

F. F. Roby, Kearney, Neb., will erect an artificial ice plant.

A foundry building will be erected for the Bridgeport (Conn.) Foundry Company.

The United Traction Company, Reading, Pa., will erect a $1,000,000 power house.

The Morse Twist Drill Company, New Bedford, Mass., has plans for a $20,000 addition.

Christian F. Weeber, Albany, N. Y., will erect an automobile factory and show place.

The Montford Machine Casting Company, Baltimore, Ind., will build several additions.

An addition is being built to the plant of the Chase Rolling Mill Company, Waterbury, Conn.

The Ansonia (Conn.) Manufacturing Company, brass goods, will move to Bridgeport, Conn.

The Globe (Ariz.) Cold Storage Company has let contract for the construction of a new plant.

The Pratt & Whitney Company, Hartford, Conn., is planning to build a large addition to its plant.

The Central Ice Company, recently capitalized at $500,000 at Mounds, Ill., will erect a large plant.

The Adams Laundry Machinery Company, Troy, N. Y., is negotiating for a site in Cohoes, N. Y.

A gas franchise was granted by the village of Winooski, Vt., to John A. Dawson. A plant will be erected.

The New Orleans (La.) Railway Company will increase the capacity of one of its power stations.

The La Crosse (Wis.) Stamping and Tool Company has plans under way for a new factory building.

The Keystone Watch Case Company, Philadelphia, Pa., will have a $50,000 addition built to its plant.

The New York, Westchester & Boston Railroad Company is erecting repair shops in Mt. Vernon, N. Y.

The Mitchell Motor Car Company, Milwaukee, Wis., has decided to erect another addition to its plant.

The Ideal Acetylene Company, Johnstown, Pa., recently organized, has let contract for the erection of a plant.

The Cumberland Telephone and Telegraph Company, Nashville, Tenn., will put up a new manufacturing plant.

It is said that an electric plant, to be operated by water power, will be erected for the Jackson Company, Nashua, N. H.

A new factory is to be built for the Greist Manufacturing Company, New Haven, Conn., makers of sewing machine attachments.

The Krueger Manufacturing Company, Milwaukee, Wis., automobile builder, is putting up a new structure to cost $25,000.

The shops of the Florence & Cripple Creek Railroad at Canon City, Colo., which burned a short time ago, are being rebuilt.

The Springfield (Ill.) Harrow Company has been incorporated. Chas. E. Wyatt, F. S. Wyatt and Ole K. Oppen, incorporators.

Fire destroyed the pattern and storage building of the Pencoyd Iron Works at West Manayunk, Pa., involving a loss of over $200,000.

The Victor Safe and Lock Company, Cincinnati, Ohio, will erect a new factory building, to be the first of a series to cost about $250,000.

The C. E. Tayntor Company, of New York, is constructing a new granite working plant at Hallowell, Me., to be equipped with electric cranes, etc.

The O. S. Kelly Manufacturing Company, builder of traction engines and threshing machines, Springfield, Ohio, will locate in Bloomington, Ill.

Fire partially destroyed Senator W. A. Clark's Butte (Mont.) Reduction Works, causing a loss of nearly half a million. The plant will be rebuilt.

The J. D. Warren Manufacturing Company of Chicago, Ill., is negotiating with the Chamber of Commerce at Rochester, N. Y., for a woodworking factory.

The Centaur Iron Works, Des Moines, Iowa, engaged in the manufacture of ornamental iron and wire work, fire escapes, etc. will put up a new factory.

The Spokane (Wash.) & Inland and Spokane Traction Companies have awarded contract for the erection of a $65,000 car barn and a machine and repair shop.

The Manufacturing Machinery Company has been incorporated in New Orleans, La., with a capital of $100,000, and will establish itself at 734-36 Baronne street.

The H. H. Franklin Manufacturing Company, Syracuse, N. Y., making automobiles, die castings, is considering plans for increasing the capacity of its plant fifty per cent.

The Michigan Brass and Copper Company, recently organized with a capital of $800,000 at Detroit, Mich., has purchased the site for a large factory. George T. Barbour is president.

The American Mining Tool Company of What Cheer, Iowa, has been purchased by George B. Simmons and others of Ottumwa, Iowa, and the plant will be moved to the latter place.

It is rumored that the Baldwin Steel Company, which has been conducting an experimental plant at Cold Spring, N. Y., has decided to establish a $1,500,000 steel plant in the Pittsburg district.

Curtis, Randall & Company, Champaign, Ill., has organized to do a manufacturing and general machine shop and foundry business. The concern has purchased the property of the Champaign Machine and Screw Company.

The North American Tool Company with a capitalization of $20,000 has opened offices in the Observatory Building, Des Moines, Iowa, and will install a factory later. The principal article of manufacture will be a sickle grinder.

The American Construction Company has been incorporated at Des Moines, Iowa., to engage in the manufacture of gas plant apparatus and the installation of plants. Capital $100,000. President, C. I. Tenney, of Mason City, Iowa.

The Waxahackie (Texas) Implement Manufacturing Company, with a capital of $50,000, has been incorporated to manufacture farming implements, machinery, etc. C. W. Gibson, F. A. Ferris, J. H. Brown, and others, incorporators.

Catalogs.

B. F. Sturtevant Co., Hyde Park, Mass. Bulletin No. 126, describing gas boosters. Illustrated 6½x9, pp. 8; paper.

H. H. Franklin Mfg. Co., Syracuse, N. Y. Handsome catalogue describing 1906 models of motor cars. Illustrated, 8x10½, 36; paper.

Motor Engine Co., 15 William st., New York. Catalogue describing Hudson gas and gasolene engines. Illustrated, 6x9, pp. 26; paper.

The D. T. Williams Valve Co., Cincinnati, Ohio. 1906 Catalogue and price list of valves, lubricators and engineering specialties. Illustrated, 6x9, pp. 60; paper.

The Removal of a Salamander from a Blast Furnace.

BY JOHN J. SMITH.

Some explanation for a topic so different from those ordinarily discussed in the pages of this journal seems to be required, and is as follows:

The outline of the operations about to be described was written in a private letter to a friend, who is one of the most distinguished contributors to this journal, and one of the most distinguished American engineers. He suggested that the matter as a whole would be of interest to the readers of the AMERICAN MACHINIST, a judgment in which the editors were kind enough to concur when the suggestion was laid before them.

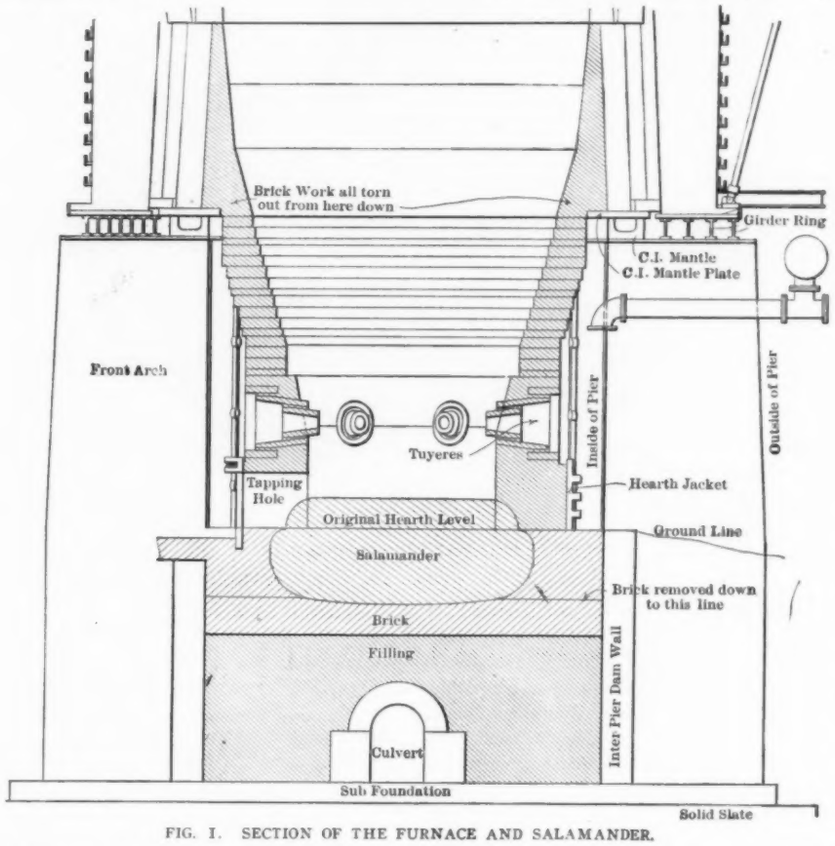


FIG. I. SECTION OF THE FURNACE AND SALAMANDER.

Some reference to the construction of the furnace is necessary and it may be stated at the beginning that this is of the very old fashioned order which has now almost entirely disappeared, in which the whole construction is of brick, brick piers taking the place of the more modern iron columns, and a brick jacket, heavily banded, replacing the steel-plate shell, with which all are familiar. Into the reasons for this construction it is not necessary to enter here. It is sufficient to say that they are valid from the dollars-and-cents standpoint.

CONSTRUCTION OF THE FURNACE.

The construction of the furnace and the position of the salamander are clearly shown in Fig. 1. When first built, the spaces between the piers were spanned by gothic arches, as was the custom in brick furnaces many years ago, but within more recent times the furnace has been rebuilt from the piers up. The arches were done away with and a brick jacket was started on plates resting on four rings of I-beams, all very heavily fish-plated together so as to resist the swelling action of the furnace. Inside of these four rings rest the cast iron trough-shaped beams, called mantles, which support the lining, independently of the brick jacket, these also being fastened together by a special connection of enormous strength. There are six piers separated by six spaces, still called "arches," though they are arches no longer; the piers and arches being roughly the same size with the exception of the front arch which is considerably wider, to give more room. From the inside corners of the piers run walls connecting them with one another. These walls serve to hold in the filling beneath the brick hearth and determine the shape of this hearth, which, of course, in plan, is a twelve-sided polygon with sides approximately equal, except the front one, which is longer. This hearth is a solid mass of fire-brick five feet thick, and on it is built what is known as the "crucible" of the furnace. This is the vertical circular portion extending up to the level of the tuyeres; and above this, the sloping portion extending to the mantles is known as the "bosh." These are the parts of the furnace exposed to the greatest destructive activity, and have to be renewed most frequently, at intervals of two to five years in good practice. The crucible is built of solid fire-brick walls to a thickness of about three feet surrounded by very heavy cast iron hearth plates, strongly bolted together, while the bosh above the tuyeres is built of fire-brick about two feet thick with rows of water-cooled plates at intervals of about a foot and a half, with heavy bands on the butt of every row of bricks, the construction being one on which no furnace manager hesitates to spend any amount of money whatever that he thinks will give him the best results.

THE FORMATION OF SALAMANDERS.

It must be stated that sometimes a furnace will work much hotter in the bottom than at others, in which case the iron and cinder will dissolve away the fire-brick and eat down to a considerable depth, also eating outwardly at the same time, sometimes eating through to the surface outside the furnace walls, making a "breakout" which furnacemen so much dread. At other times the furnace will work relatively cold in the bottom and will build up a mass of iron on the hearth which it will refuse to melt out. The reason for this action is not fully understood, and will simply have to be taken as a fact. The mass of iron left in the hearth when the furnace is blown out for repairs has been known from time immemorial as a "salamander."

When the furnace under discussion was last blown out for the rebuilding of her hearth, crucible and bosh, it was after a blast in which the bottom had been constantly very high, so that the top of the salamander was about 18 inches above the true hearth level. On several previous occasions when the furnace had been repaired, the top of the salamander had been just about at the true hearth level, and the central portion of the mass was left in place and brick fitted to it around the sides to restore the hearth to its proper height outside of it. The result of these two circumstances was that the salamander made during the last blast was made on top of the one made during the previous blasts, and the surface of the latter having, of course, been fused, the new salamander was absolutely fused to it, so that except around the outside, where the shape was as I have indicated, they were absolutely one homogeneous mass. The question has been asked whether this mass was all iron or whether it was more or less mixed with coke, fire-brick, lime, cinder, etc., and to this I have to say that the portion under discussion, and that which I have shown in the drawing was solid cast iron, and nothing else.

BEGINNING OPERATIONS.

It will be understood that the hearth-

plates had been removed, the tuyeres taken out, and the crucible and bosh walls, bands, cooling-plates and all had been torn down, absolutely, below the level of the mantels, so that the furnace was open from side to side, like a rotunda supported on pillars. We had had previous experience with salamanders, weighing as much as 35 tons, and the problems of the job were, therefore, not new in starting after this one. They simply consisted in digging as long as the material could be dug or gadded in the center, and then, after solid iron was reached there, continuing the same process down the sides so as to expose the structure of the salamander, after which to gad it up from its bed, drill it and break it with dynamite was a comparatively simple matter. The depth, however, to which it was necessary to go around the sides in these cases was small, generally not over a foot or eighteen inches, and the digging therefore was comparatively open and easy. It will be understood that this digging refers to the digging and gadding out of the fire-brick in the polygonal space between the piers and inter-pier dam walls, and the sides of the salamander, spaces two or three feet wide.

In digging down, as the mass became gradually more and more solid, containing more iron and less other material, large pieces were exposed which were not a part of the main salamander, or at least were attached to it so lightly that they could be detached without unusual difficulty. These pieces lay in the relation of onion peel to an onion, although much thicker in proportion, and a number of these were removed weighing from one to four or five tons each. When the cracks (filled with some material not iron) between these pieces and the salamander proper were exposed by digging and gadding, dynamite was put in and the pieces were shot loose from the main mass and lifted out. As we proceeded, it became evident that still deeper removal of the ring of fire-brick between the salamander and the piers was necessary, and a steam-driven rock drill was brought into requisition with which holes were driven into this hard mass, and by the application of small charges of dynamite it was shot away without injuring the piers, a matter of prime importance which it was necessary to keep continually before us.

It is necessary to say that this fire-brick exposed to the action of the iron becomes tremendously hard, tough and heavy, more like a granite rock than fire-brick, in many instances, so that the removal of this alone was a matter of considerable difficulty and, with the large pieces of "onion peel," required about 2½ days from the time that the surface of the salamander was exposed, the force being rather short and the working space very cramped. As the digging proceeded without reaching the bottom of the salamander, it became evident that it was of unusual size, and it may be stated here that subsequent measurement showed it to be five feet deep by twelve feet in diameter, corresponding to a weight of 135 tons; this, as before mentioned, being independent of the pieces of onion peel already removed, probably fifteen or twenty tons more.

Knowing that drilling would be necessary to break this mass, and having no portable rotary drills to be driven by steam or air at command, we set about getting these by wire. Two were ordered from two different concerns, with all possible urgency. One came about two days after we had begun drilling by hand and after fighting with it with the whole mechanical force for three or four days to keep it in order, it was finally determined that the speed was less, and the cost more, than could be obtained by hand-driven ratchet drills, and it was abandoned. The other drill came the day after the last piece of the salamander had been removed, and was tested for acceptance on one of the pieces where it lay in the "bone yard." It was found that the machine would drive a 1½-inch high-speed drill at a high rate of speed and would cut four inches in five minutes with all ease. It would in fact have been worth at least half of the total time it actually took to do the job, to us, but it got there too late to be of use. The other drill which proved to be a detriment rather than a help, got there in time. Such are the ways of Fate.

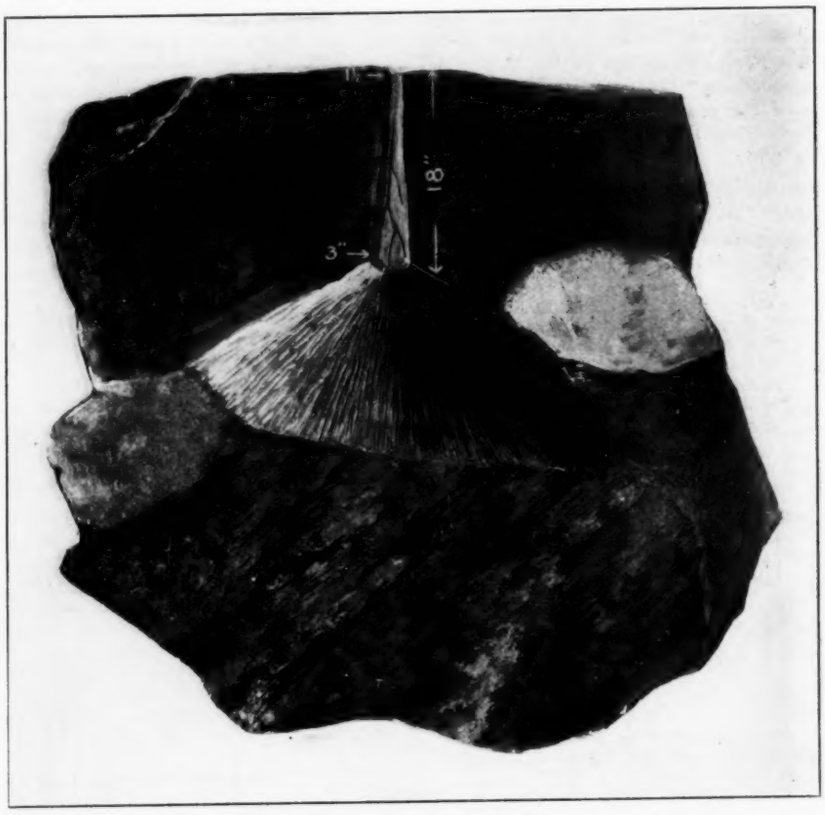


FIG. 2. EFFECT OF DYNAMITE.

DRILLING THE BLAST HOLES.

Without waiting for the arrival of these drills, a heavy timber was put across the furnace from pier to pier, centrally, about three feet above the surface of the salamander. Two bars of 1-in. square high-speed steel had been procured for this job and had been forged into old fashioned flat-lip drills with square taper shanks to fit the sockets of the powerful special ratchets kept on hard for this and similar jobs. Three of these were set at work with three men on each, and kept going all day and as nearly the same at night as our force would permit. A row of holes was drilled straight across the top of the salamander about 15 inches apart, eight in all, and all started with the intention of going to the depth of 18 inches, but the iron was hard and tough and our impatience great, so that some of the later ones fell short of this depth by a couple of inches.

I have, however, out-run my story in two particulars. The steam-driven rock drill was set up to strike what seemed to be a seam between the top and bottom salamanders, and drilled in this. It got in only a short distance before it was practically in solid iron. By sticking to it, we got in perhaps 12 inches in this way, but the progress was slow, and the noise and inconvenience great. Moreover the hole did not go where we wanted it, in line with the others across the top. This hole was subsequently loaded and fired, but while it broke off a piece of a half ton or so, it had no marked effect on the final solution of the problem.

DRILLING WITH THE ELECTRIC ARC.

It is probably known to the readers of this journal that if a carbon supplied with an electric current of proper voltage and in proper quantity be used as a burner on a metallic mass, the mass can be cut by melting, at a very rapid rate. In recent years advantage has been taken of this to bore holes through the walls and into the tapping hole of furnaces which have become partially chilled, using these carbons in place of the oil burners, which I described at page 623, Vol. 28, Part 2. The best results have been obtained with alternating current at 50 volts or less and with 1,000 amperes of current, the carbon rod being three inches in diameter by six feet long. Having acquired an electric plant of limited size since the strenuous occasion for which the oil burners were improvised, it was thought wise to have carbons on hand to meet such an emergency should it arise again, though the current available was direct current and at 220 volts, the capacity of the machine being 180 amperes. For this reason carbons 1½ inches in diameter four feet long were obtained. When the magnitude of the salamander was fully revealed and it was known that power drills could not reach us for a couple of days, with visions of days of weary pulling at ratchet drills ahead of us, all methods of accomplishing the desired result were eagerly considered, and among others, it seemed possible that holes might be burnt into this huge mass with the carbon burner, and it was determined to try it. A piece of wrought iron 2 inches in diameter was bored out to be a tight fit on the carbon at one end, and on an iron rod 1 inch in diameter at the other end. It was then split lengthwise and clamps put over it. The carbon was put into one end, the iron rod about two feet long in the other, and the clamps drawn up. A piece of 1-inch hose was slipped over the iron rod, and the cable soldered to the projecting end of the latter. One wire was grounded on the salamander, a rheostat was improvised from an oil barrel filled with salt water, in the bottom of which was sunk a piece of tin-plate with one of the terminals soldered to it. A coil of tin-plate having several square feet of surface was soldered to the other terminal, and the depth to which the end of this coil was immersed in the salt water gave some control of the quantity of current passing.

Having had a little experience with the effect of the electric arc on the eyes several years before, steel-melters' glasses were obtained at the same time that the carbon rods were, and with a man stationed at the rheostat, I put on the glasses, took hold of the rubber hose, which made an insulated handle for the carbon rod, sat down in one of the arches, and touched the end of the carbon for as brief a space as possible to the salamander and drew it away. After a few trials an arc was formed, and presently the metal began to flow and run away. The carbon could soon be advanced a little and a good pocket was started in the side of the salamander. The rig was heavy and awkward to control, so that some changing about was necessary, and time was lost in that way, but in about an hour of actual working time, we had burnt a hole 14 inches deep into the side of the salamander, the hole being something like 3 inches in diameter, and, of course, very irregular in shape.

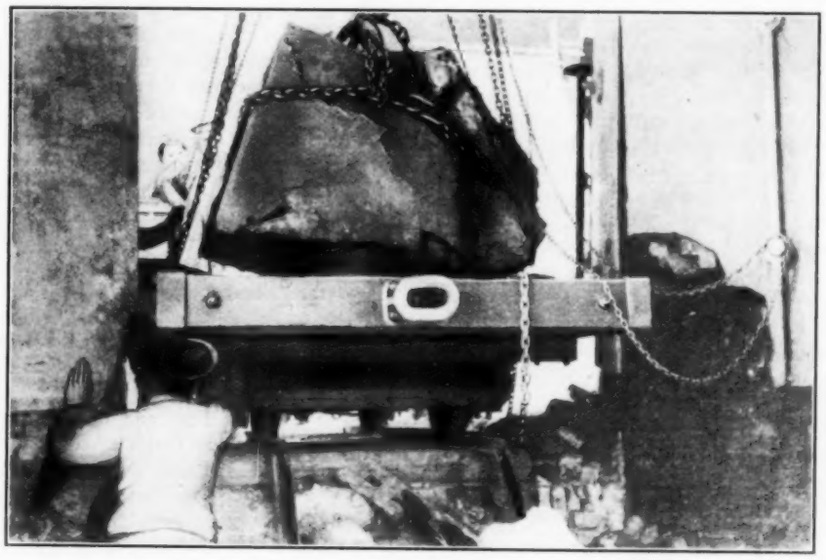


FIG. 3. A PIECE OF THE SALAMANDER READY FOR REMOVAL.

The engineer had a steady job standing by the circuit-breaker on the generator to put it in as fast as it came out, and part of the time it kept him pretty busy. When the arc was once formed, if the rheostat had not been too deeply immersed at the time, the engine and generator could stagger along under the load, but if the arc broke and was reformed with the rheostat deeply immersed, it was impossible to make the contact so short as not to allow such a rush of current as would throw the circuit-breaker. Various minor charges were made in the direction of getting better control of the apparatus and reducing the danger to the generator. Then six o'clock came on Saturday night. Some attempt was made to work the burner that evening, but having been at the burner-end of the line during the afternoon I went down to the power house during the evening to see how the generator and engine were standing up under the treatment. The sight I saw will live long in my memory. The engine and generator were both evidently suffering, but it was the belt which was calculated to attract the most attention; at one instant running so slack that it almost dragged the floor; at the next a load would be thrown on it which would cause the bottom belt to jump up and the top to fall till they almost slapped together; jumping, dancing, surging, slipping almost off the pulleys, squealling, howling, such a sight in the belt line for variety and severity has probably not often been seen.

A few minutes of this was sufficient to convince me that I did not want any of it, at least while I was not around, and the attempt to do any more burning that night was abandoned. The next morning the rheostat was so amended as to choke down the current very materially, so that the engine was able to stagger along under its load, but in much greater proportion than we had saved the engine we had reduced the efficiency of the burner, and after a short further trial it was obvious that it was not wise to risk the destruction of a good electric plant to save $100 worth of hand drilling, even though the time element was important. The whole attempt, therefore, was abandoned.

If we had had the same amount of electric power, or preferably double as much, at 50 volts or less instead of 220, making the amperage from five to ten times as great, there is no doubt that holes could have been bored satisfactorily and rapidly in this way, always with the limitation that the holes must be in the sides of the salamander rather than in the top, and must have an upward slope so that the melted metal will run out. In addition to the effect of the high voltage in reducing the number of amperes for a given amount of power, the high voltage in itself was a distinct disadvantage, as it permitted the formation of a long arc, and after the carbon had penetrated some distance, it was very difficult to control the point of melting because the arc would jump to the side of the hole as easily as to the front, while if the distance to the front was made too small to counteract this tendency, the amount of current flowing became so great as to throw the circuit-breaker.

EFFECTS OF LARGE ARCS ON THE PERSON.

It is wise, before leaving this subject altogether, to say something as to the effect of one of these large arcs on those coming near it. An ordinary arc light consumes considerably less than a horse power of energy. Consider then an arc light consuming sixty or seventy horse power and some idea of the intensity of the light will be obtained. This light must never, even for five seconds, be looked at with the naked eye. The peculiar violet color of the light probably has much to do with its efficiency in certain directions. This violet color accompanies the actinic or chemical rays of the spectrum whose activities are not yet fully understood. If one of these high power arcs be watched for a few seconds without the very heaviest blue glasses, no particular ill-effect will be noticed at the time, but during the succeeding night the rash onlooker will wake up feeling as though not a grain, but a teaspoonful, of the sharpest sand had been poured directly upon each eyeball, and that each grain was cutting in a different direction at the same time. This description is from memory now about seven years old, and is not, it is believed, too strong to suit the case. While I have no knowledge that blindness would result from long exposure of the eyes to this powerful arc, I have little doubt such would be the case.

In addition to its effect on the eyes, the effect of the arc on the skin is not to be ignored. Scarcely any sensation of heat will be noticed, but after a time a smarting sensation will be felt on all parts of the face or hands exposed to the direct radiation of the arc. Persons of different complexion are more or less susceptible to this action, precisely as they are to that of sun-burn. I personally directed this arc for, I think, not to exceed forty minutes in all, and during the succeeding week lost every particle of skin from my face, except that of my eye-lids which had been protected by the blue glasses. The hands of course can be protected by gloves, which should always be done, while in order to operate one of these arcs without danger of this unpleasant effect, a screen of lightly woven blue cloth should be hung up between the operator's face and the arc itself. With the intense light of the arc this is partially transparent, and enough can be seen to direct the arc from behind it. This expedient we found too late for one or two of us.

THE USE OF DYNAMITE.

Monday, the next day after abandoning the use of the electric burner, we started in with the ratchet drills, as already described, and when they were down to the depths mentioned, we decided that we would take the chance and begin firing them. In work of this kind where the hole is expensive, the cost of dynamite becomes of relatively little importance, and the first requisite is not to run any risk of destroying the hole. This is easily done by putting too much dynamite in the hole at first, filling it up nearly to the top and leaving only a small portion of tamping. The upper portion of the dynamite being relatively little resisted by the top of the hole tends to burst that, and the lower portion of the charge augment the action, so that either the top of the hole may be shivered, or a flat cone of material may be blown bodily out from near the bottom of the hole destroying it altogether. If, on the other hand, small charges be employed with a large quantity of tamping, the element of time comes in, the dynamite works on the metal at the bottom of the hole before the tamping has time to yield, but the charge being so deep in the piece, no bursting takes place. The metal around the bottom of the hole, however, is compressed and driven outwardly in all directions, not very much at the first shot, but increasingly as the shots are repeated.

This action has two effects; compressing the metal and forcing it outward from the hole causing it to give way circumferentially, so that the hole not only becomes much larger but deep radial fissures formed in the metal that is left, perhaps an inch or two in depth. A line of these have a decidedly weakening effect on the piece which contains them, several times more than that of the holes alone. At the same time, the enlargement of the hole enables a much larger quantity of dynamite to be put in, and still retain the quantity of tamping with which the earlier holes were fired.

Another point of vast importance is the grade of dynamite used. As a general proposition it is safe to say that where relatively little breaking power and great throwing power are desired, the lower grades, 30 and 40 per cent., should be used, but where little throwing power and the greatest rending power are desired, the higher grades should be used. The whole business is a matter of time, and the higher grades have a shorter time of combustion than the lower ones. Sixty per cent. was the highest grade we had on hand and this was used throughout. The last point of course is obvious, even to those who have had no experience with explosives, and that is that all the holes must be fired at once. For this purpose electric primers are made, one of which is put into each hole, the wires leading therefrom being joined together in series across all the holes, and the terminals connected to a "battery," so-called, worked by hand power, driving down the handle of which causes a sufficient current to explode twenty to forty holes under ordinary circumstances, but on account of the whole mass on which we were operating being iron, and the ease with which grounds could occur, we were unable to get more than two or three holes to go at once, which caused a tremendous loss of time, and increase of danger. Accordingly the lead wires were connected to the extension plug which fitted an electric light socket. When all was ready the socket was turned, and the result was immediate. There were no misfires or failures to fire all the holes after that.

FIRING THE SHOTS.

With these preliminaries explained, it will hardly be necessary to say that we did not try or want to break the whole mass at one shot. We put from one-half stick to a stick of dynamite in each hole and fired them as fast as we could without any other delay than that required to swab out the holes with a wet rag after each round. Much sooner than we expected, somewhere about the eighth round, we began to notice cracks running from some of the holes in the direction of the line of holes. These increased after each shot, and at the same time the pockets at the bottom of the holes were given an increased capacity for dynamite after each shot, so that we began to realize that it was safe to load them more heavily without danger of losing them. The charge was accordingly run up to two or three sticks per hole, and after about two rounds of this, the piece was split wide open from end to end, and top to bottom, right through the line of holes as evenly as if it had been a block of chestnut wood. The remaining pieces, however, weighed sixty tons or more each, and as they would require to be broken up sufficiently to go into the furnace some time, and as the labor of removal would be much less if they would be broken up to moderate size as they lay, it was decided to make no attempt to move the two halves from their position, once they were clearly split open, but to put the drills back to work and drill them at right angles to the first line, and quarter the piece in the same way that we had halved it. This was accordingly done. The experience gained on the first lot of holes showed that we could get along with less holes, especially if they were made a little deeper, and that we could save time in this way. Only about three holes were put in each of the halves, but these went down 18 and 20 inches. These were treated in the same way, and though one of the halves proved very obstinate, they were soon split as the whole piece had been, though not quite so evenly.

CURIOUS EFFECTS OF THE DYNAMITE.

In splitting these we noticed for the first time what became very plain several times afterwards during the remainder of the operation. This was that the dynamite not only forced the metal around the hole outwardly so that the 1½-inch holes were increased in some cases to 5 and 6 inches in diameter by this action, as shown in Fig. 2, but it also worked on the metal in the bottom of the hole which it compressed in a cone with a definite angle. The compression of the metal downward and its compression and consequent split-

ting radially had as a resultant the formation of an almost perfect cone with an apex angle of about 120 degrees. The tendency had evidently been for this cone to blow out as a plug, but the charge being well above the center, this was impossible, and the metal of the cone had simply been compressed upon itself.

REMOVING THE PIECES.

After the pieces were quartered they were still large enough to be perfectly safe from theft, and in order to handle them it was decided that they had best be brought down to the capacity of the 12-ton Yale & Towne blocks, described in an article called "Two Home-Made Travelling Cranes," and published at page 695, Vol. 28, Part 2. The drilling and shooting process was, therefore, continued until the largest piece weighed as nearly as we could estimate, not more than 15 tons, which overload we were willing to risk on the blocks.

Fortunately we had an excellent point of suspension for these. By putting a heavy billet of iron across the space between the flanges of the two inner I-beams in the front arch, and suspending a loop of chain therefrom, we were enabled to hold these blocks up to something which had ample strength to carry them without danger or difficulty. We therefore chained the pieces and lifted them up with these blocks in the way shown in Fig. 3, which shows one of the largest pieces, estimated to weigh about fifteen tons. It will be seen that a railroad track of three feet gage, had been laid into the front arch, right up to the space inside the piers, the ends of the rails having been bent down sharply to prevent the pieces from hanging on them as they were pulled up and out into the arch. All of these pieces were handled in this way, and the smaller ones, particularly the scales or pieces of onion peel, mentioned above, weighing not over four or five tons, were handled with the four-ton Yale & Towne blocks, described in the same article as mentioned above, hung in the same way but in one of the side arches nearest to the piece to be lifted.

After the job was over and done with, in looking back over it no way could be thought of in which these large pieces could have been handled any more safely, quickly or satisfactorily, except by the possession of a travelling crane of sufficient capacity to take them up bodily from their bed on the furnace hearth, and back out with them. This we did not have beyond the capacity of six tons, and very few of the pieces were small enough for it to handle.

In the matter of time, the salamander was quartered Friday night of the week on which drilling was begun, and by the following Thursday it was all broken up and cleaned out, practically ready for the bricklayers to begin laying the new hearth. Most of the ten days consumed was spent in drilling. Had we had at the beginning the powerful steam rotary drill of which mention has been made, the job would have been done in about five days, possibly a little less, but not much. The handling of masses of this kind by any sort of hand apparatus necessarily consumes more or less time.

EXTENT OF INJURY TO THE FURNACE.

Some will naturally be curious to know about the damage done by the blasting outside of that intentionally done to the salamander. Of this there was very little. The blast pipe is shown in Fig. 1 projecting into the back arch and each arch is provided with one of these. Two of them were injured; on one the ell was broken, and another had a clean hole about a third the size of one's hand, punched right into it. One of these pieces of damage was done by wreckless loading of the hole burned in with the carbon burner, and showed what would be the result of loading holes heavily the first time. Not expecting much from this, it was heavily loaded and fired with the others. A piece of perhaps half ton weight was blown off, several chips of the size of one's double fist or larger flew from it, and the hole was entirely ruined, but the salamander as a body was not "phased." One of the "chips" struck the elbow of the blast pipe on its way out and caused the principal damage that was done by the blasting. The bricks on the outside of the piers were slightly scarred in some places, and the noses of the bricks in the culvert, six or seven feet below, had jumped off as though they had been nipped in a vise, presumably by the compressive action of the blasting on the culvert, which threw its interior layer into compression, and caused this action.

The Economy and Efficiency of The Steam Turbine.

The London *Times* is publishing a series of articles on steam turbines, which contains some interesting data concerning the showing made by machines of the "Parsons" horizontal, multiple-expansion, parallel, full annular flow type, that are built in England by C. A. Parsons & Co., Willans & Robinson, and Richardson, Westgarth & Co., in Switzerland by Brown, Boveri & Co., and in the United States by the Allis-Chalmers Company, of Milwaukee, Wisconsin.

Turbines of this form of construction, with an aggregate capacity of over 1,000,000 H. P., are now operated in various cities of Europe and the United States for the generation of electric power. Several of the turbines in operation at the plant of the Newcastle Electric Supply Company are each capable of developing 6,000 H. P. at 1,200 revolutions, under normal conditions, and over 10,000 H. P. on overload. Turbines of similar size and design, put in operation in Switzerland by Messrs. Brown, Boveri & Co., are each designed for a normal output of 12,000 H. P., while similar progress is being made by French and Austrian engineers.

As to the use of marine turbines for torpedo-boat destroyers and high speed passenger vessels the *Times* makes some very significant comparisons showing the results attained with vessels of identical construction except for the type of engines used. The *Amethyst* and the *Topaz* constructed after the same pattern, were selected by the British Admiralty for the purpose of making a series of exhaustive tests, the former being equipped with turbines and the latter with reciprocating engines. The contract speed of the vessels was 21¾ knots and the tests showed that at all speeds above 14½ knots the turbine-equipped *Amethyst* was more economical, namely: 15% at 18 knots, 31% at 20½ knots and 36% at 21$^{1}/_{10}$ knots. At full power in each vessel the *Amethyst* showed 42% more than required by contract on the coal allowed. The *Amethyst* also reached a speed of 23.5 knots during these tests and the *Topaz* only 22.1 knots.

More noteworthy results on a larger scale have recently been afforded by the trials of two Cunard liners, the *Carmania* and the *Caronia*, each of 30,000 tons displacement and 23,000 I. H. P., the former being fitted out with turbines and the latter with quadruple expansion engines of the latest design. Essential facts concerning the trials of these vessels have been widely published and generally read; but the statement that the *Carmania* beat the *Caronia* by about one knot does not give an adequate idea of the relative efficiency and economy of the turbines. It must be remembered that one knot in speed means about 16% more horse-power and that, therefore, the *Carmania* would appear to be about 16% more economical than her sister vessel driven by the most highly developed type of reciprocating engines; further, that the test of the *Carmania* was the first trial of turbines on so large a scale, and it may reasonably be expected that improvements in detail will improve upon the noteworthy results obtained. Members of the engineering profession will await with great interest the trials of the two gigantic Cunard turbine vessels of 25 knots speed and 60,000 to 70,000 H. P., now building on the Clyde and the Tyne.

Consul General Guenther, of Frankfort, Germany, reports that the experiments with the new turbine steamer "Princess Elizabeth," of the Ostende-Dover Line, have been surprisingly successful. The steamer is said to have averaged 24 knots an hour, thereby exceeding the record of all other passenger steamers. The three steam turbines of the "Parsons" system installed in the new boat develop an aggregate of 10,000 horse-power. This steamer will carry more than 900 passengers.—*Consular and Trade Reports.*

Balancing at High Speeds.

BY E. R. DOUGLAS.

It is a fact more or less well known that a good standing balance is not necessarily a good "running balance," but the cause of this is not commonly understood, nor are the methods to be pursued to achieve a running balance familiar. The cause of this probably is that for most jobs the ordinary methods are good enough. Very few rotating parts of machinery have speeds high enough to cause, with the liberal bearings and massive parts commonly in use, any serious trouble if the standing balance has been carefully adjusted. With the advent of the steam turbine, however, new conditions arise. Here we have extremely high speeds combined usually with heavy rotating masses, and the methods of balancing which had previously been good enough are found to be entirely insufficient.

THE IMPORTANCE OF ACCURATE BALANCING IN TURBINE WORK.

The importance of accurate balancing on this class of work will be appreciated when it is pointed out that a weight of *one ounce*, rotating 3600 r. p. m. at one foot radius, produces an unbalanced centrifugal force of *276 pounds;* and this speed is a common one with steam turbines. In slower running machinery it would require a much heavier body to produce the same effect. At 300 r. p. m. it would require nine pounds to cause the same unbalance that results from one ounce at 3600 r. p. m. Now an unbalanced weight of nine pounds may be easy enough to find and correct, where one ounce calls for exceptional skill and accuracy.

But a body whose static balance is correct to a fraction of an ounce may be anything but balanced when in rapid rotation. The greater its length between bearings as compared to its diameter, the greater the chance of discrepancy.

This is made clear by consideration of Fig. 1. This shows a long, heavy body mounted in two bearings *A, B*. The letters *C, D*, indicate "heavy spots." They are shown as diametrically opposite to each other and at opposite ends of the body. If their statical moments about the axis be equal, the body is in perfect standing balance. But when running, spot *C* sets up a centrifugal force *C E*, and spot *D* a force *D F*, and since these are in opposite directions and *l* inches apart, they cause a twisting moment on the body which may be very severe, one pulling one way and the other the other way.

How shall we balance it? Obviously, one way would be to put directly opposite each heavy spot, and at the same radius, an equal balance weight; or, if this were not convenient, such a weight at such a radius that its statical moment about the axis would just equal that of its "heavy spot." Such are shown at *G* and *H*, and if properly adjusted, centrifugal force *G J* just balances *C E*, and *H K* balances *D F*, and the trouble is corrected.

BALANCING IN SECTIONS.

But it is obvious that the heavy spots may be located anywhere along the body, or there may be more than two. How are we to determine their location and amount?

One eminently practical way, and one well adapted to several forms of turbine and of electric turbo-generators, is to divide the body transversely into as many rings or sections as possible and balance each separately to obtain a static balance. If the sections are thin and numerous the result may be very good indeed. It may be laid down as a general rule that the body should be, so far as convenient, made up in separate rings, each of which is separately put in the best possible balance. Further reasons for this will appear later. There are however, cases where this is impracticable, or where, after assembly, a running unbalanced does, after all, develop.

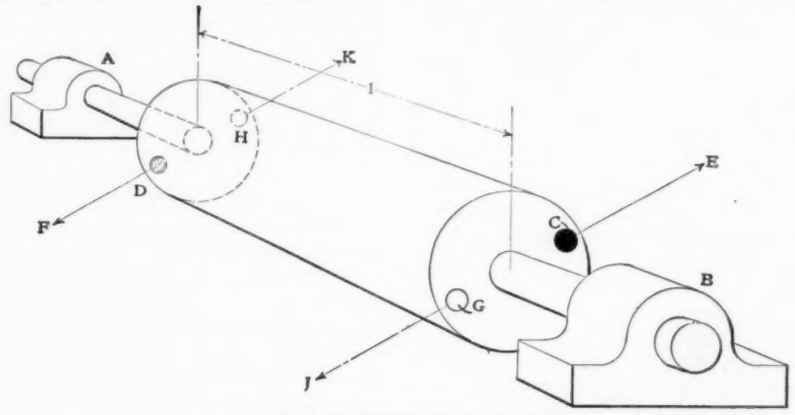


FIG. 1. BALANCING AT HIGH SPEEDS.

The question remains, how to locate and correct it.

THEORETICAL CONSIDERATIONS.

Most problems can be approached either from the theoretical or the practical side, although the most successful attack will make use of both. This problem is no exception.

The theoretical side has been well covered, and new refinements are being taken up. Many of these are based on experimentally determined data.

Theory helps at the start in one important particular. It shows, simply, that *any unbalanced system of rotating bodies, mounted on a stiff shaft, can be balanced by two weights, located at proper radii in two planes perpendicular to the shaft.*

Moreover, of the eight factors involved, viz., location of the two planes, amount of the two weights, angular locations of the weights and the radii at which they are placed, any four may be assigned at the start and the other four determined. This simplifies things greatly.

It is generally most convenient to fix the position of the planes and the radii of the weights by providing in the designs for two circumferential sets of balancing pockets, one near each end, and then determine the proper weights to be put in them and their angular locations.

So much for theory. Suppose we have a rotating body on a stiff shaft, provided with circumferential sets of balancing pockets near each end, which body shows a running unbalance. How shall we proceed?

FINDING THE HIGH SIDE.

The first step is to find the "high side" of the rotating body, as by holding a piece of chalk against it. To be practicable, there should be a finished cylindrical surface somewhere near each end of the body preferably over the balancing pockets, and their trueness should be tested by turning the body over slowly in its own bearings while a lathe indicator or a surface gage is brought up to them. If not perfectly true a light cut should be taken off while still turning slowly, to make them so. These will then be the reference surfaces. A good material for marking is the chalk-like substance called "Kiel," either red or blue. It will show on iron, brass, or copper. A red or blue pencil will do. Ordinary chalk does not stick long enough to be of much use.

Bring the body up to full speed, or as near it as the vibration will allow, and hold the kiel lightly against each of the finished surfaces. Shut down, and after coming to rest turn over slowly by hand, examining the kiel-marks carefully. It will generally be seen that one side of each finished ring is marked while the other is clean, showing in which way each end of the body was displaced in running. Usually the positions of the high spots on the two ends will not be the same. Each high spot should have its middle point carefully located and marked on the body near it by white paint or otherwise. It may be more convenient to locate the middle of the clean or "low" spot and take that off the high spot as directly opposite.

EFFECTS OF MOMENTUM, ELASTICITY AND FRICTION.

At first thought it might appear that the high spot would indicate directly the position of the heavy spot, and that the balance weight should be entirely opposite. This is far from the truth. Generally speaking, for any position of the heavy spot, the high spot may come anywhere around the circumference. Fundamental facts are these: The three things which

determine the position of the high spot with reference to that of the heavy spot are momentum, elasticity, and friction of the parts which are in vibration.

Consider the first alone. Suppose the body to rotate on a stiff shaft in bearings which are absolutely unconstrained and free to move in any direction, without friction of any sort. Momentum alone limits the motion of the body due to the unbalanced forces. Under this condition the high spot will come *directly opposite the heavy spot.*

Consider the second limitation. Suppose the body to be without appreciable momentum (as by consisting entirely of a very light mass at a very long radius) and to rotate in bearings whose motion is restrained in every direction only by equal elasticity. The same conditions would result if it rotated on an elastic and very light shaft in bearings of great rigidity. Then would the high spot come *directly over the heavy spot.*

Consider the third limitation. Suppose the body to be without appreciable momentum and to rotate on a stiff shaft in bearings the motion of which in every direction is limited entirely by friction. Then will the high spot come *ninety degrees back of the heavy spot,* in a direction that is opposite to that of rotation.

The results of these three conditions are illustrated in Fig. 2. To one versed in electrical science there is a striking analogy between these effects of momentum, elasticity, and friction, and the electrical effects of inductance, capacity, and resistance, the component of the amount of displacement of the body in vibration corresponding to the quantity of electricity, or charge, the component of the velocity of vibration to the current, and the position of the high spot to the phase of the charge.

LOCATING THE HEAVY SPOT.

To return to our problem: Every body in rotation is affected more or less by each of these three factors. The location of the high spot will depend entirely on the relations between them. Since we do not know these we must once more resort to experiment.

If it be practicable, rotate the body in the opposite direction and, having first removed the kiel marks with sandpaper, apply the kiel again. Slowing down, observe these new marks. It will generally be found that they are in a different position than the first ones. Since for opposite rotation the high spot should be displaced from the heavy spot by an equal amount in the opposite direction, the heavy spot must be half way between the two marks; on which side can be told only by trial.

To determine this, first mark the new high spots with paint or otherwise in such a manner as to distinguish them from the first. Put lead balancing weights temporarily in the balancing pockets on both ends half way between the first and second marks. These weights should be of considerable size so as, if possible, to more than balance the heavy spots. Then come slowly up to or toward speed and, first having cleaned off the previous marks with sandpaper, apply the kiel again. If the weights are heavy enough and the position is right the new high spots should be opposite to those first determined for the same direction of rotation. If they are not, either the weights are on the wrong

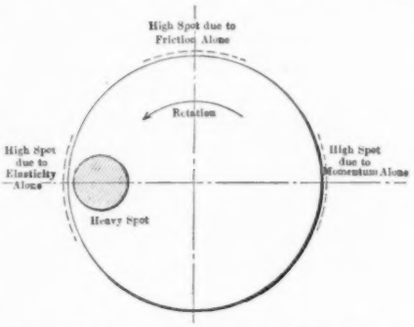


FIG. 2. BALANCING AT HIGH SPEEDS.

side of the body and should be shifted just 180°, or the weights are not heavy enough. In either case a few trials and some common sense should reverse the marks.

THE USE OF HEAVY TRIAL WEIGHTS.

If it be impracticable to run in the opposite direction the case is not quite so easy. The process then is to apply weights of considerable size on each end in any position, making them heavy enough to outweigh many times the original heavy spots. Then, coming slowly as far as practicable up toward speed, mark the new high spots. Their position with reference to the weights applied will indicate, if those weights be heavy enough, the general relation which holds in the body between a heavy spot and its high spot. It may need a few trials with the weights in different positions completely to verify this. When known, the positions of the original heavy spots, and of the weights required to balance them, are at once determinable. It will be advisable to prove the correctness of this determination by moving the heavy weights to the positions thus in-

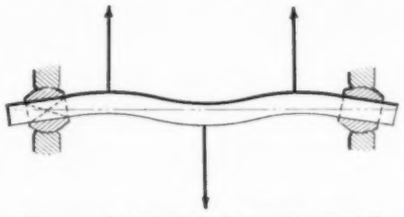


FIG. 3. BALANCING AT HIGH SPEEDS.

dicated and observing whether the marks are "reversed," as they should be.

Whichever method may have been pursued, the rest is comparatively simple after the original marks have been reversed; for the correct position of the balance weights has then been found and it remians only to reduce their amounts, a little at a time first one and then the other, until the correct balance, as shown by true running and absence of vibration, is obtained. The temporary weights may then be made permanent.

It must not be supposed that the above process of balancing is rapid or easy. Many more trials than are described will have to be made, for purposes of verification and for other reasons, and bodies running as fast as steam turbines take a good deal of time in coming up to speed and slowing down. But any attempt to balance them without some rational line of procedure is time wasted, and that here described has given good results.

BALANCING BODIES CARRIED BY SLENDER SHAFTS.

Everything so far with one exception has referred to bodies rotating on very stiff shafts. If the shafts be long and slender, and so somewhat flexible, new conditions may enter. Under such conditions a number of heavy spots, located at different places along the body, may each cause a bend or kink in the shaft, somewhat as indicated in Fig. 3. Of course, where the body can be made up entirely of rings, separately balanced, the possibility of this is almost completely removed, but this cannot always be done. In such cases it will not be sufficient to have a ring of balancing pockets at each end of the body, but other such rings must be provided at intermediate points. Unless the shaft be very flexible indeed, one or two intermediate rings should be sufficient; of course the shaft should always be designed to have as much stiffness as possible. Finished reference surfaces should then be provided as nearly as possible over each row of balancing pockets, and kiel marks put on each to determine their high spots. The general methods of procedure are the same as with stiff shafts, but many more trials will usually have to be made before the balance is correct.

DEFLECTION OF ELASTIC SHAFTS.

The phenomena attending the rotation of loaded elastic shafts are of considerable interest. When such bodies are run, any slight unbalance will, of course, set up a centrifugal force tending to bend the center of the shaft slightly out from the axis of rotation, in the direction of the unbalance. As the speed and the centrifugal force increase the amount of this deflection also increases, but at a faster rate than the former quantities. A speed is finally reached at which the deflection would be indefinitely great, except that, of course the shaft would break before this was reached if the constraint of the hub and bearings did not prevent it, or if the speed were not increased so rapidly that the shaft had no time to deflect to the breaking point. This speed is called the "critical speed" of the shaft. Its value depends on the flexibility of the shaft and on the amount and distribution of the weights on it.

If the speed be raised so rapidly as safely to pass the critical value, a curious

thing occurs; the deflection, which, as already explained, for light bodies rotating on flexible shafts in rigid bearings is in the direction of the unbalance, changes to the opposite side and, as the speed is increased, decreases in amount. If the speed be made very great indeed, the body finally reaches a condition of rotation about its center of gravity, the shaft being slightly bent.

This is the state of affairs which obtains in the De Laval turbine, where the wheel is thin and comparatively light and the shaft long and flexible, so that the resulting stresses on the bearings are small. It is designed to run above its critical speed even if somewhat out of balance.

Turbines of the Parsons and other types and turbo-electric generators cannot, however, be made on this plan. Even when they can be made up of separately balanced rings it will sometimes happen that a slight unbalance will show after assembling, and with turbo-generators the case is worse on account of the wire windings which have to be put on them after the other parts are assembled. It is, therefore, essential to be able to give them a final correct running balance.

SUPPORTING AND DRIVING THE WORK.

In order to eliminate, as far as possible, in this work, all unknown quantities, it is advisable to mount the body to be balanced, if possible, in bearings which are unconstrained in at least one direction, by carrying the bearings separately on rollers, or suspending them from supports above, or otherwise, so that their sidewise motion may be as free as possible, and drive by a vertical belt. The kiel should then be held in contact on the horizontal diameter. At the start the speed should be only high enough to develop perceptible vibration and allow of marking the high spots. As the balance approaches perfection the speed may be raised toward its full value without difficulty. Means should be provided to hold the bearings at their proper distance from each other and prevent endwise vibration.

With a device such as this the effects of elasticity and friction are reduced to a minimum and momentum has practically full sway in determining the location of the high spots. The work is, to that extent, made easier.

Referring to our paragraph on the peculiar echoes noted by Professor Woods, and which paragraph was published at page 109, a correspondent says he has noticed the same phenomenon when walking on cement sidewalks next to corrugated iron walls, and that similar echoes, much louder, may be heard from the puffing of locomotives when moving alongside of corrugated iron walls of grain elevators, etc. The echo, he says, seems to be somewhat louder in cold than in warm weather.

Don't get into a rut.

The French Westinghouse Works at Havre.

BY EMILE GUARINI.

The Westinghouse Company, Ltd., owns in France two large establishments. The Freinville works, the chief object of which is the manufacture of pneumatic and electro-pneumatic apparatus, are put up at Sevran (Seine et Oise), at a distance of nine miles from Paris. The plant at Havre, which is still larger, is devoted to the manufacture of mechanical and electrical plant, and is erected at Craville Ste. Honorine, close to the Tancarville canal and to the main line of the Western Railway.

The Tancarville canal places the works in direct communication with the navigable waterways, and a branch from the Western Railway extends into the warehouses, fitting shops and foundries. The neighboring town is essentially industrial, and possesses establishments covering all branches of manufacture.

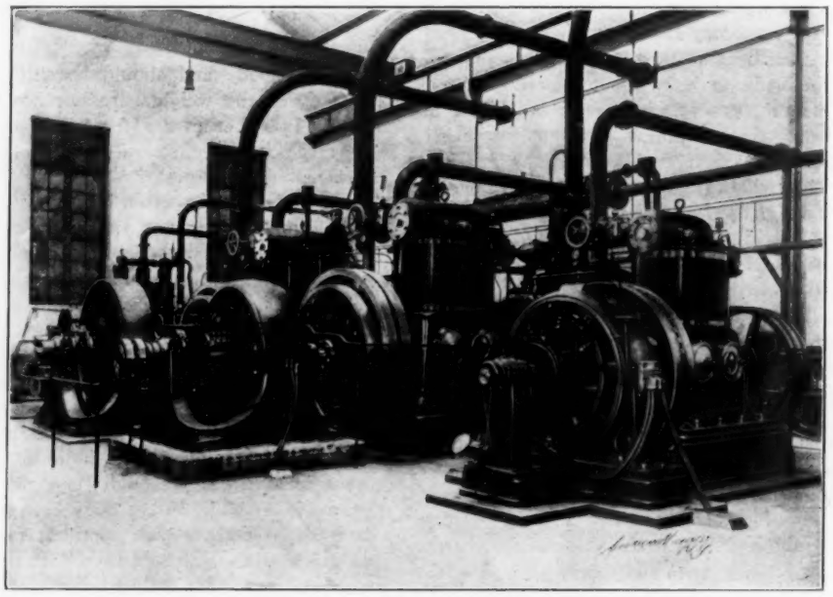


FIG. 1. VIEW IN POWER HOUSE.

Besides the workshops properly so called, the Westinghouse establishments comprise also accessories workshops, foundries, forges, annealing furnaces, modeling shops, etc. The boiler-room contains three boilers of the Babcock & Wilcox type, which supply steam to the engine-room, which is separated from the other branches and contains four groups of generators. One of these, a Willans-Westinghouse set, working at 125 volts, constitutes a reserve for use in the case of emergency.

The engine-room, Fig. 1, supplies direct and alternating current at different voltages for test purposes; the lamps are fed under 110 volts, the cranes under 500 volts and the motors under 220 volts.

The three-phase current is produced by one of three main Westinghouse groups; this latter, of a capacity of 400 horse-power, for current at 220 volts. A second group of the same power gives direct current at 500 volts. The third group is of 200 horse-power, and supplies direct current under 125 volts. Three transformers of the monophase type are also installed, in case an accident should render it necessary to have recourse to the reserve for the production of alternating current; they are also used to reduce the tension to 220 volts. The different currents are sent to the various workshops, and notably to the principal workshop, by the aid of a large switchboard and auxiliary boards in the various rooms.

The large machine tools are driven independently by three-phase motors of the Westinghouse type, without collector or brushes.

For the smaller machines the system of driving by groups is used. The motors are of the same type as those described above.

The different sections of the main workshop are placed parallel to each other, and are divided into three main parts. Each of these handles a special class of work and manufactures parts of a given size; thus the dimensions of the shops are appropriate to the size of the machines to be made, and machine tools of corresponding size can be grouped together. In the first section of the works large machines, such as dynamos, electric motors, steam engines, gas engines, etc., of over 100 horse-power, are constructed. Fig. 2 represents this workshop. An electric traveling crane of 62 feet span traverses the room. It is provided with four Westinghouse series motors, working at a pressure of 500 volts. The crane has a main carriage of a capacity of 30 tons and an auxiliary hook, for small loads, which is quite independent of the other.

Among the planers, lathes and boring

mills there are some able to plane, drill, bore and turn work weighing more than 50 tons, and having a diameter of 40 feet. Besides these gigantic machines there are also smaller ones, and automatic precision machines for shaping, etc.

The second part of the workshops is devoted to the manufacture of dynamos, electric motors, tramway motors, etc., of 100 horse-power and below; in the third part there are constructed commutating apparatus and the like. These sections are served by five traveling cranes, and each of the sections is independent of the others and possesses all the machines which are necessary thereto. The arrangement of the tools is made upon a plan which permits of methodic work, all the crude parts and raw materials arriving at one end and traversing the various sections of each room in well-determined order. In this way all detached parts arrive at the end opposite the entrance, at the assembling and adjusting rooms, where they are put together to form the complete machines. On leaving this department they pass to the testing department, and then to the shipping room.

Independently of final trials to which the assembled parts are subjected, prior to leaving the workshops, the whole process of manufacture and construction is carried out under a well-organized system of inspection and testing, whereby all defective parts are discovered without being subjected to the final test. All the parts are interchangeable, being made to gage and templet, and only those which are free from flaws reach the assembling shops. Fig. 3 shows some heavy apparatus assembled and tested in the large machine shop.

The different accessory workshops (foundries, forges, etc.) are grouped to the rear of the workshops, and also the storage rooms and the general warehouse. This latter supplies all the raw material necessary for the manufacture of the machines in the different departments of the works.

The foundry, with its three cupolas, is shown in Fig. 4. It is provided with 5-ton and 20-ton electric traveling cranes, and has a monthly capacity of 15 tons of copper and 300 tons of castings; the three cupolas have a capacity of 5, 6 and 8 tons. The dimensions of the foundry, including the stores, etc., are 162x130 feet.

All the workshops are large, spacious and well ventilated, and in winter are warmed by hot air. All dust, caused by the burnishing and planing machines, micanite saws, etc., is drawn off by the aid of special exhaust apparatus; and clean and convenient lavatories are provided for the use of the workmen.

FIG. 2. VIEW IN MACHINE SHOP.

Before the Canadian Society of Civil Engineers, W. H. Laurie recently gave the relative costs per brake horse-power per year developed by means of gasolene, steam and gas engines as follows: Gasolene engines, 78.00; gas engine with illuminating gas, 46.80; steam engine, 37.44; semi-water gas from anthracite, 7.80; semi-water gas from gas coke, 5.74; water and producer gas from bituminous coal, 5.00. These costs were based on the assumption of 312 days of 10 hrs.; one-eighth gallon of gasolene at 20 cts. for a brake horse-power; 15 cubic feet illuminating gas at $4 per ton; 1 lb. of $5 a ton anthracite coal for semi-water gas; .92 lb. gas coke at $4 a ton for semi-water gas; and .8 lb. bituminous coal at $4 per ton for producer gas.—*Railway & Engineering Review.*

Bronze implements were successfully cast around iron cores 2800 years ago.

Apprenticeship and Industrial Education.

BY FORREST E. CARDULLO.

The growing scarcity of skilled workmen seems to be forcing itself upon the attention of the managers of industrial enterprises generally, if we may believe the columns of the technical press. The cause of the evil, in the opinion of many, is first the gradual disappearance of the apprentice system, and second the "big wages quick" mania. Both reasons are doubtless correct, but the trouble is no one has gone behind them to find if there are not others more important and deep seated than these. Because I am more intimately acquainted with conditions in the machine shop than in other parts of the industrial field, my thoughts in these few paragraphs will refer more particularly to that phase of the situation than to any other. However the principles at stake are the same whether we discuss the machine shop, the foundry or some other shop requiring from its operatives unusual intelligence or manual skill. The apprentice system has long served to develop this intelligence and skill in a very satisfactory manner, and the thoughtful man is impelled to ask, "Why has it well nigh disappeared? Why do half-trained young men insist on 'big wages quick' and get them?"

WORKING AT CROSS PURPOSES.

To my mind, the reasons are not far to seek. In the first place, the apprentice system, in the opinion of the managers of industrial enterprises, was a benevolent enterprise for some other man to conduct, and for themselves to profit by. Their reasoning, we may imagine, was about as follows: "Why should I spend three, four, or five years training apprentices, when I can hire the ones my neighbor has trained by giving them a little more money than he does? A few weeks' trial will show me the good ones, whom I will keep, and the poor ones, whom I will fire. Thus I will have the good workmen, and my neighbor will have his labor for his pains."

EFFECT OF MODERN SHOP CONDITIONS.

The second reason for the break-down of the apprentice system is that it has not adapted itself to modern conditions. There is a general tendency on the part of managers to cut down the relative proportion of non-productive labor cost. This means, necessarily, less and less supervision of apprentices, even if the number be reduced also. From this reduction in supervision several very important results follow, the least important and most obvious of which is the fact that the apprentice learns more slowly, and less thoroughly. This defect could readily be remedied by a longer course of training, and would necessarily involve, in justice to the apprentice, a higher rate of wages throughout the course. A more serious result, however, is the giving to apprentices of work needing but little overseeing, and requiring but a poor grade of intelligence. There follows directly the fact that such work will not improve the workman, and does not accomplish the object which both he and his employer should have in mind, namely the development of a skilled and resourceful mechanic. This is the great reason why the apprentice system as it is generally conducted, is not adapted to modern conditions.

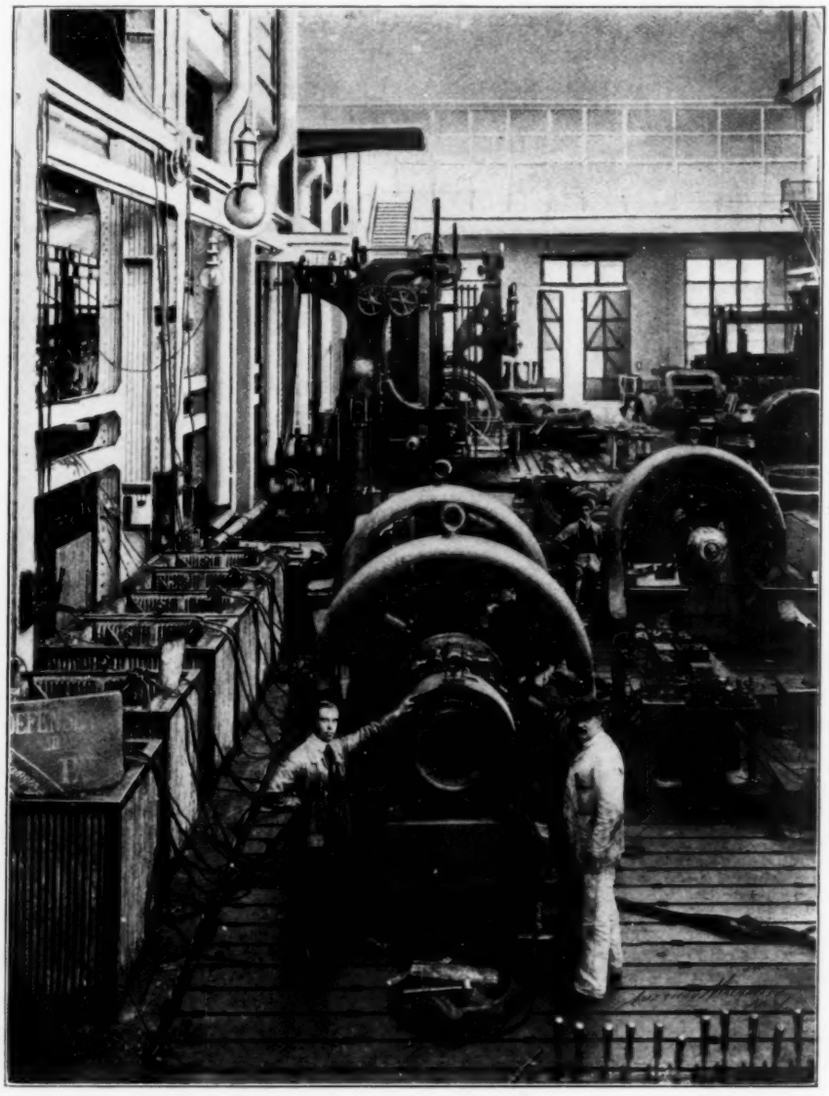


FIG. 3. TESTING DEPARTMENT.

The third reason, like the second, has grown out of a combination of managerial shortsightedness, and modern development. Tools cost more now than they did thirty years ago. They do a vastly larger quantity of work. The value of the castings or forgings that they finish in a week is many-fold what it ever was before. They are much more complicated. Therefore an error in their operation is much more costly than it ever was before. Accordingly the apprentice has been relegated to some cheap machine operating on equally cheap stock. I do not object to the use of such machinery. On the contrary, I belive it to be desirable and necessary, both from the standpoint of the employer and employee. I am objecting now to the compelling of apprentice boys to spend almost their entire time at work which accomplishes absolutely nothing toward their industrial education.

The fourth reason is that with the growth in size of shops, it has become customary to employ men proficient in a single line of work in preference to men of all round mechanical ability. Naturally so much knowledge and training is not required of a lathe or bench hand, as was required of the machinist of the olden days, who was expected to run any machine in the shop, and therefore he will not receive as high wages. Indeed in some shops a large part of the work is done by common laborers, who have been trained to some particular machine or

piece of work. From the manager's standpoint, it is a good thing to substitute an unskilled laborer for a skilled mechanic, if in some way as much work can be gotten from the former as from the latter. Economy in operating expenses gained by cutting down the average wage per man, however, is economy dearly bought. To enter into a discussion of the futility of such scheme would be to write a book on political economy, which I have no intention of doing. While the training of laborers for special service is an expedient often rendered necessary by the condition of the labor market, it is not, and never will be a substitute for the training of skilled workmen for a more general field.

APPRENTICES' WAGES TOO LOW.

The fifth reason is that apprentices' wages have not kept pace with the rise in the cost of living. While machinists' wages have risen in my memory, from $2.25 to $3.50 per day, apprentice's wages are still $3.00 per week. A prominent

FIG. 4. A CORNER OF THE FOUNDRY.

shop superintendent lately expressed the opinion that the average boy of 16 was worthless in the shop. On the other hand, one of 18 or 19 soon becomes a valuable workman, not only because of his greater development and intelligence but also because he is in general, more earnest and reliable. In addition, he generally has two years more schooling. This two years' difference in age makes a very considerable difference in the wages that the prospective apprentice can command in the general labor market, with the result that a low wage for apprentices acts as a sieve, to sift out the older, and presumably more valuable boys, and deliver them over to the general labor market, retaining the younger and less valuable ones in the shop. These younger boys consist in a large measure of those who, through stupidity, idleness or poverty, are early compelled to leave school, and they make a very undesirable class from which to recruit apprentices.

FAULTS OF APPRENTICES.

I am aware that, in explanation of his side of the case, the manager or superintendent can bring a terrible indictment against the average apprentice. He will explain the failure of the system by saying that the apprentice is lazy, idle, stupid, careless, vicious, or any one of a dozen other undesirable things. I will agree that he has many faults, but they are the same faults that the apprentice system has dealt with successfully for centuries back. The fault is not so much with the raw material, as with the manner of training it. The boys of today are no better nor worse than their fathers before them, and if they do not make as good workmen as their fathers, it is because the training they receive is not as well adapted to their requirements.

This does not mean that no attempt should be made to secure the best class of boys and young men as apprentices. It pays better to train a young fellow who gives promise of developing into a capable and reliable mechanic, than one who is idle and careless. A large part of the apprenticeship problem consists in devising ways and means for attracting the right kind of young men and holding them. Money alone will not do it. That attracts all equally. What is far more effective is a thorough and valuable system of instruction, attractive surroundings, the prospect of permanent satisfactory employment, and a feeling of mutual good will, between employer and employee.

THE TRUE THEORY OF APPRENTICESHIP.

Before we continue this discussion, it may be well for the reader to understand what I believe to be the true theory of apprenticeship. Ordinarily the employee sells the employer his labor, and receives therefor his wages, the wages being in the market at least, if not in equity, a fair return for that labor. Whatever instruction the employee may receive is simply that necessary to do his assigned task, and is not to take up an undue proportion of his overseer's time. The apprentice, on the other hand, exchanges his labor for wages and instruction. The value of the labor he gives, is the value of unskilled labor in the market, and he pays for the instruction he receives the difference between a laborer's wages and his own. Thus if a boy is employed usefully in a shop, and by proper overseeing a reasonable output is being obtained from him, the price he is paying for his instruction is the wages of a laborer, say $9 per week, less his own wages, say $4 per week, or $5 per week. Bear in mind that this is not paid for ordinary superintendence such as every workman must receive, nor for the experience gained, nor the chance of observation, nor the opportunity to use machines or tools, but solely for unusual superintendence, and extraordinary breakage, and destruction of material. As the apprentice becomes more skillful, the value of the work he performs rises also, so that he still pays a considerable sum for his instruction.

OBJECTIONS ANSWERED.

At this point I feel obliged to stop, and answer some of the objections which my readers have doubtless raised to my statements. I think the first one will be that the output of the average apprentice is such that he barely earns the wages actually paid him, to say nothing of any allowance for instruction. To this I will reply that the reason is that he gets so little oversight and instruction that he can do no better. The same remark applies to the objection that the breakage that apprentices cause is excessive. An objection less easily disposed of is that they are generally boys, who therefore could not get laborers' wages, but it is equally true that if special inducements were not offered in the matter of instruction, laborers would have to be hired to do the work. I can see no reason why the young fellow who operates a shaper should get $5 less a week than the man who wheels out the chips he makes, simply because he is not yet 21.

When a boy enters a shop as an apprentice, he does so under the implied understanding that every reasonable opportunity will be afforded him to learn a trade. There is a mutual obligation, first on the part of the employer, to furnish sufficient instruction, so that with reasonable industry and application, the apprentice will at the end of his apprenticeship, be a fairly expert journeyman, and second, the obligation on the part of the employee to perform service of sufficient value to pays for his wages and instruction. Therefore the employer who offers a course of instruction in work not requiring unusual skill and intelligence, in the guise of an apprenticeship, is on a par morally with the gold-brick man, for he trades bogus instruction for valuable service.

BONDING APPRENTICES.

I have nothing to say now concerning the lazy or vicious apprentice. For the employer burdened with such, the remedy is summary dismissal. He should not remain as a bad example to the rest, nor should the rest suffer in any degree for his misbehavior. Still the best of boys have their off days, and sometimes, for some real or fancied grievance, or for the sake of a little more wages from another shop, an apprentice will leave. In order to prevent this, it is advisable to have a bond from the apprentice. This practice of binding apprentices has several very good results. In the first place, it tends to keep out undesirable apprentices, for a boy will not enter into a bound contract unless he has a serious intention of following out the course. In the next place, the appren-

tice will be more careful and diligent, for fear of losing his bond. Again, it results in a better grade of instruction, for an apprentice is unlikely to bind himself, unless he is assured that the course will indeed be of value to him. Also, the fact that the bond is required is likely to add to the esteem in which the course is held, by giving the idea that the employer considers it one of value.

Inasmuch as the bond is a powerful instrument for the attracting of the right kind of young men and holding them, it is worth our while to try and overcome its no less great and obvious disadvantages. These are about as follows: First, the keeping of a boy at a trade he finds distasteful, and at which he will never make a success. Second, the injustice of not returning the bond when an apprentice is discharged for some cause not his deliberate fault, as slackness of work, natural incompetence, or compulsory removal. Third, if a bond is required, only those who can afford to advance the amount of the bond would ever be taken into the shop, thus debarring many young fellows from learning a trade. Fourth, the inevitable dissatisfaction of those who feel themselves obliged to quit, and so lose their bonds, and the possibility of these making trouble in the shop through their friends.

It seems to me that these objections may be met, each and all, by some slight modification in the system. In regard to the first one, every apprentice should serve a probationary period, at the end of which he should be free to go if he wishes, without forfeiting his bond. He should not be allowed to leave during this period, nor at any subsequent time during his apprenticeship, but only at the end of the time of probation. The second objection may be met by the employer returning the amount of the bond, or a large percentage of it, whenever an apprentice is obliged to quit work through no fault of his own. In case there is any disagreement as to whether the apprentice is at fault, the matter is a proper one for arbitration. It will generally be unnecessary to discharge an apprentice for infraction of the rules, as punishment can generally be meted out by fines, suspension, or some similar method. When it is necessary to discharge a boy for some offense of particular flagrance, the apprentice should forfeit his bond. The third objection may be overcome in two ways. Either the shop itself may advance the bond in the case of a particularly promising apprentice, taking his note for it, or if a probationary period is served, the shop may retain the wages, to be paid over at the end of the period in case the apprentice decides to quit then, or otherwise retained as the bond, to the end of the apprenticeship. The last difficulty can be met only by a spirit of perfect fairness on the part of the employer. An apprentice will often feel obliged to leave, as for instance, when subject to petty persecution from his shop mates. If he is not given his bond, those who understand the true inwardness of the matter will not be slow to condemn the company, and the affair will surely produce friction. The remedy, to my mind, is an impartial arbitration of the case; more often than not, it will result in a satisfactory settlement of the affair without anyone leaving. The remedies proposed are not the only ones available, of course. Probably they are not the best ones. They are only mentioned to show that the difficulties are not insuperable.

TRADE SCHOOLS.

Without taking sides in the matter, or indeed at all indicating my preference, I would like to propose for the thoughtful consideration of your readers the following three points: First, is it advisable for the state, or for that matter for private generosity, to establish trade schools, which shall serve as standards of industrial education in commercial establishments? Second, shall a private establishment be obliged to give a certificate of proficiency to all who complete a course of apprenticeship with them? Third, shall there be state supervision of the apprenticeship systems, just as there is state supervision of the schools, or of our manufacturing plants? There is much to be said on either side of these questions, and it is idle to attempt a thorough solution of the apprentice question without considering them.

LABOR UNIONS AND APPRENTICESHIP.

There is one matter upon which I feel very strongly, and that is the attitude the labor unions should assume toward industrial education. In my opinion, the labor union is a trust, and the commodity it has to sell is labor. There are only two methods by which a trust can lawfully control the market, either by furnishing a better commodity, or by furnishing it for less money. It is not desirable that the unions should furnish their labor for less money than others, so therefore it is incumbent upon them to furnish a better quality than others. This means that the unions owe it to themselves to undertake in a rational manner the regulation of the apprentice system. At present they confine themselves to the regulation of the number of apprentices, leaving untouched the far more important question of quality of instruction. So long as managers are obliged to go outside of the ranks of properly trained journeymen for the labor they need, and the unions are obliged to assimilate those the managers take in, so long their control of the labor market will be incomplete. The wages of the members of a labor union, in the long run, will be strictly proportional to their average skill. If the union will not adequately supply the labor market with skilled labor, it will be obliged to assimilate a vast body of unskilled labor thrust upon it, with disastrous results to its average skill, and to its wage rate. The presence of untrained or half trained mechanics in a union is a menace to its continued supremacy. It seems to me then, that it is to the best interests of the unions to see that the market is adequately supplied with highly skilled union labor, and in pursuance of this object it is necessary that they exercise a more thorough supervision of the apprenticeship system.

The need for highly skilled workmen never grows less. It may disappear for some operation, only to reappear for a dozen others. So far as I know, there are only two methods of obtaining skilled workmen; by means of trade schools, or apprenticeship systems. While the trade school has its advantages, and in my opinion is the best place to properly train skilled workmen, trade schools will ever continue to be unable to turn them out in the number in which the industrial situation will demand them. We are therefore forced to employ the apprenticeship system, whether we like it or not. To overcome the present-day disadvantages of the system, I recommend as follows.

RECOMMENDATIONS.

First, that the apprentice shall be bound to serve the full term of his apprenticeship, provided that some satisfactory method shall be adopted to overcome the difficulties generally accompanying this practice.

Second, that the amount of instruction and oversight which the apprentices receive be very largely increased, not only in order that they may have more and better instruction, but in order that their output and general efficiency may be largely increased.

Third, that apprentices' wages be advanced to such a point that they will attract and retain the better, rather than the less desirable class of young men.

Fourth, that the shop equipment should include machines especially adapted for the use of apprentices. They should be modern, powerful, of reasonable size, accurate, as simple as it is possible to make them, and above all, fool-proof and cheap.

Fifth, that the operations reserved for apprentices should be so arranged and of such a character as to advance their industrial education. This will necessarily involve a reduction in the proportional amount of time spent in operating automatic machinery.

Sixth, the adoption of ideas which will retain the best class of young men as apprentices, and the vigorous culling out of those who do not promise to be satisfactory.

A contemporary says "The first step toward reducing the cost of manufacturing any article is in acquiring exact knowledge of what its present cost is." That may be true, but the costs of producing many thousands of things have been reduced by improved tools and methods without any idea of the actual cost by the older tools and methods.

Making Countershaft Drums at the Works of the Landis Tool Company.

BY H. F. NOYES.

These drums are used for driving the emery wheels on the grinding machines manufactured by this firm, for which class of machinery, because of its necessarily high speed, it is essential that the drums be nicely balanced and run true. On account of their length, and to reduce the weight, the larger sizes of these drums are made of sheet steel, the one shown in Fig. 1 being 20 inches in diameter and nearly 14 feet long.

The drums are built up in sections, each section comprising a roll of ⅛-inch sheet steel, 24 inches wide, fitted between two gray-iron centers, the edges of the roll being turned to an angle of 60 degrees to fit the centers, as shown by the detail Fig. 2; enough sections being assembled and bolted together to make a drum of the required length. The steel sections are formed or rolled into shape, from sheets about 6 feet long and 24 inches wide. To bend them readily a furnace and set of rolls are provided, illustrated by the photograph Fig. 3, sectional plan Fig. 4 and sectional elevation of the rolls Fig. 5.

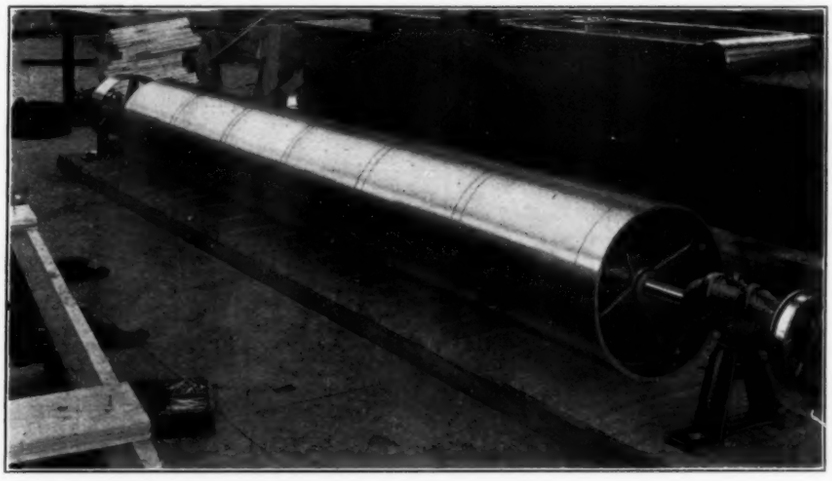


FIG. 1. A LONG BELT DRUM.

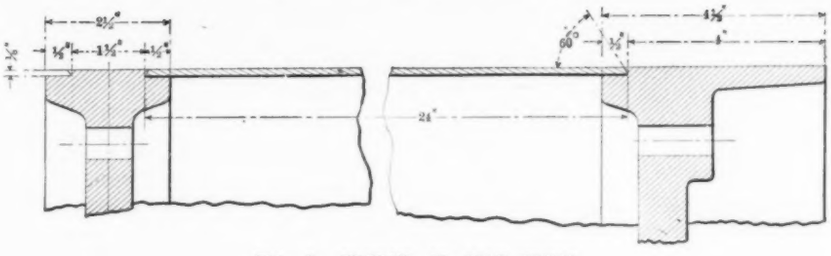


FIG. 2. SECTION OF BELT DRUM.

The furnace comprises a long and narrow fire-box, with admission at the top and bottom for oil burners at one side, and flues about midway between the burners and the ends of the furnace opening to the atmosphere at the top of the furnace. From one end of the furnace a narrow tapering passage leads to the bending rolls as shown in Fig. 4. These comprise a central roll 20⅛ inches in diameter, surrounded by clusters of smaller rolls 4 inches in diameter. Three of these smaller rolls are placed in close proximity to the point where the sheet first meets the larger roll, and they do most of the work of bending, while the others, supplemented by intermediate guide bars bent to the form of the large roll, chiefly do duty as guides.

The large and small drums are all geared together, the diameters of rolls and gears being such that the peripheral speed of the small rolls slightly exceeds that of the large one. The object of this is to slightly draw the outer surface of the sheet in rolling, a provision that has been found necessary to the successful working of the machine. The various diameters are shown in Fig. 5. The large roll is

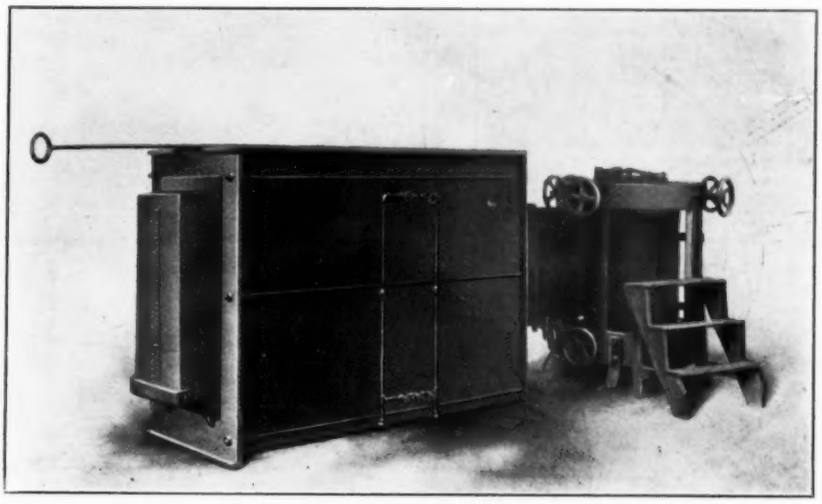


FIG. 3. FURNACE AND ROLLS.

driven through a bevel gear and pinion which are in turn driven from a motor, the speed of the latter being reduced by gearing, not shown in the drawings.

The smaller rolls are carried on horizontally adjustable housings, which can be readily adjusted in or out to vary the distance of the guide rolls from the large roll. In practice this distance is made slightly greater than the thickness of the sheet, for if the rolls are adjusted too close, the sheets are liable to stick too tight on the central roll and be difficult to remove.

The central roll is guided at the top by a center held in a heavy hinged support which can be readily thrown back for the removal of the sections.

The steel in the form of sheets is shoved into the furnace on edge and allowed to remain until thoroughly heated, when the sheets are pushed on through the furnace until one edge is engaged by the rolls which have been previously set in motion. The operator in control of the motor, throws the switch at a signal from the operator at the rolls, just as the section has been entirely wrapped around the central roll. The upper roll support is then removed and the section pulled off the drum, this operation usually requiring two men. Two or three men are used to operate the furnace and they turn out 50 or 60 sections a day, a lot of which, fresh from the rolls is shown in Fig. 6.

The next operation is jointing the edges, which is done by the aid of a planer fixture shown in Fig. 7. It comprises an accurately turned drum, supported at one end by a stiff angle plate, and at the other by a lighter support which can be readily removed to admit placing the sections

on, and removing them from the drum. The sections are firmly clamped by four hoop clamps, each clamp being held in position by an adjusting screw in each of two parallel bars which are firmly fastened to the supports at each end of the drum. The drum is of such a diameter that the edges of the sections do not quite meet, and each of the hoops being open at the top, a clear path is left for the planer tool. The edges of the section are planed off until they are a certain distance apart as determined by gages, such that when the edges are brought together the desired outside diameter of the section will be obtained.

The next operation is bevelling the ends, which is done by clamping the section on a drum which is pressed on a lathe mandrel and the ends are then bevelled off to the desired angle.

The sections are then assembled and balanced. While no machining is done to the outside of these sections, it is surprising how closely they agree with the diameters of the turned cast iron ends and centers when assembled, so closely that the joint between the two is hardly perceptible, and that chiefly owing to the different appearance of the two metals. This is shown in Fig. 1.

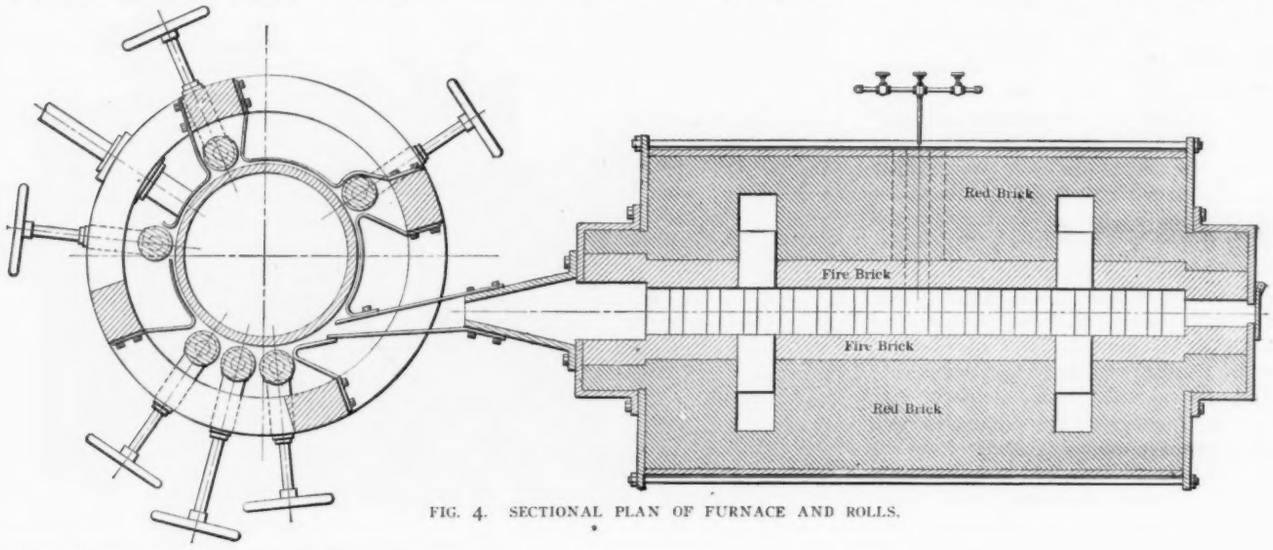


FIG. 4. SECTIONAL PLAN OF FURNACE AND ROLLS.

Lighting Machine Tools.

The Street Railway Journal has the following editorial which deserves reading by the owners and superintendents of shops, especially of those shops which at night resemble a gloomy cavern:

Although articles and comments have appeared from time to time on shop lighting, very little has been said specifically on the lighting of separate machine tools. Many shops could make much-needed improvements if attention were given to this important detail, as there are very few shops that do not have machines installed in dark corners, and at this season of the year in all shops artificial light must be depended upon entirely for a period of about two hours each day. In some shops about the only provision for lighting machine tools is to suspend a 16 candle-power lamp over the machine. No shade is provided, and there is nothing to prevent the lamp swinging from side to side. As the suspending cord is usually very long, the lamp is swinging most of the time.

It is demanding too much of a workman to require him to do accurate work under such a light. No matter how hard he tries, he is likely to make errors, the cost of which will many times pay for

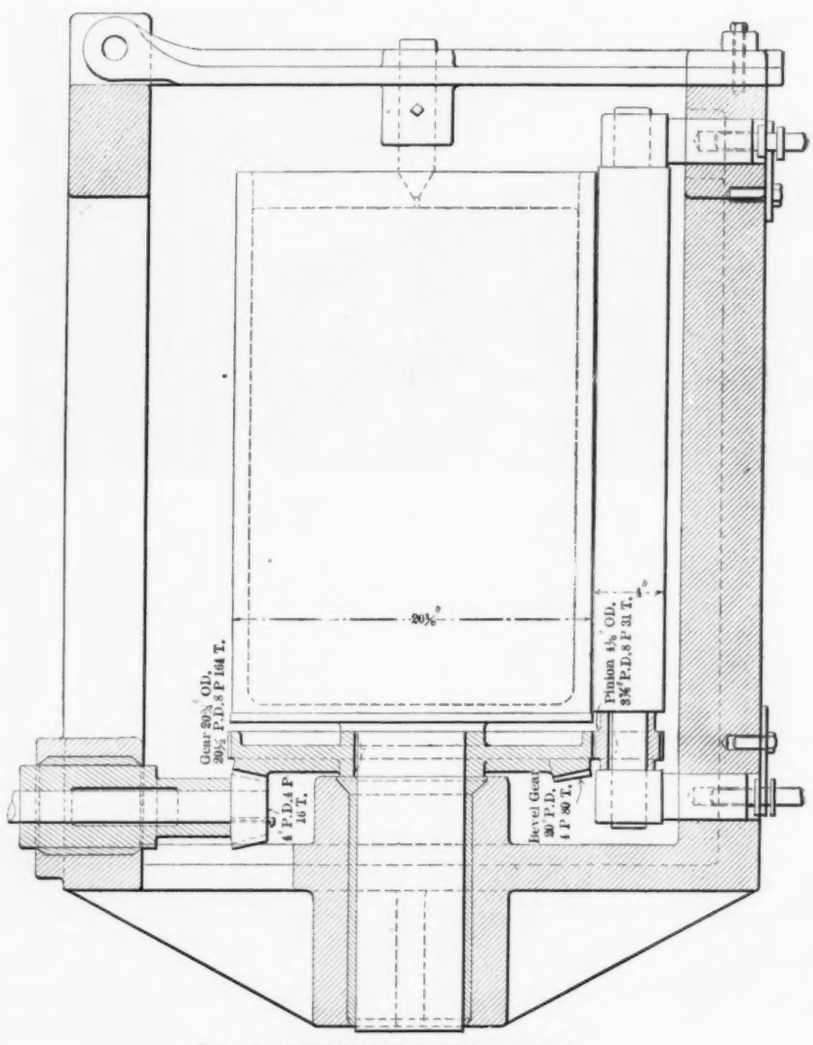


FIG. 5. SECTIONAL ELEVATION OF ROLLS.

the installation of lights in the proper manner. Even if no errors are made, it is a costly plan to fail properly to light machines. A man can never work as fast when he is compelled to feel rather than see what he is doing, and the slow rate at which work is turned out with inadequate lighting is in itself a sufficient incentive to better the arrangements. Then, again, the workman, after he has made a few mistakes in setting his tool and has reached the point of exasperation, loses pride in his work, and when this happens, both the management and the workman are the losers.

Lights for machine tools should be placed on brackets or stands in such a manner that they are held rigidly. The support should be provided with adjustable arms, so that the lamp may be set down close to the work. Such stands or brackets may be easily constructed in the machine shop, and the cost of the material will be practically nothing. By all means, the lamps should be provided with shades of some sort. Sometimes large shades are not permissible, as they prevent placing the lamp as near the work as desirable. But there is a sufficient number of shades and types of shades on the market to permit of a selection of a style most suitable to each machine.

Often, however, one lamp, even if it be a 32 candle-power one, is not sufficient to properly light a machine. If so, the cost of current for extra lamps should not be reckoned, and especially so in a street railway shop, where the current usually costs about .3c per kilowatt-hour. Assuming this rate, a lamp-hour costs about .015 cent. At this cost, it is a rather safe risk to install all the lamps which have the least possibility of being used.

It isn't necessary to employ an illuminating engineer to place lamps properly about a shop. All that is required is to give the workmen to understand that the lamps will be fixed for them as they may desire. If such a hint were given them and their wishes were then followed, in many shops much more satisfactory machine work would be turned out, and it would be executed much more rapidly.

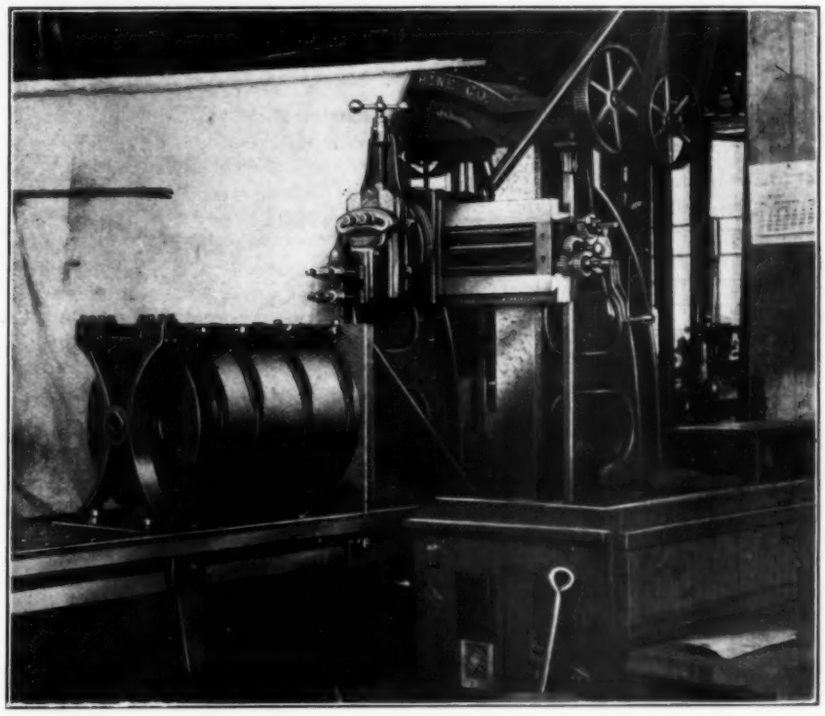


FIG. 7. FIXTURE FOR JOINING THE EDGES.

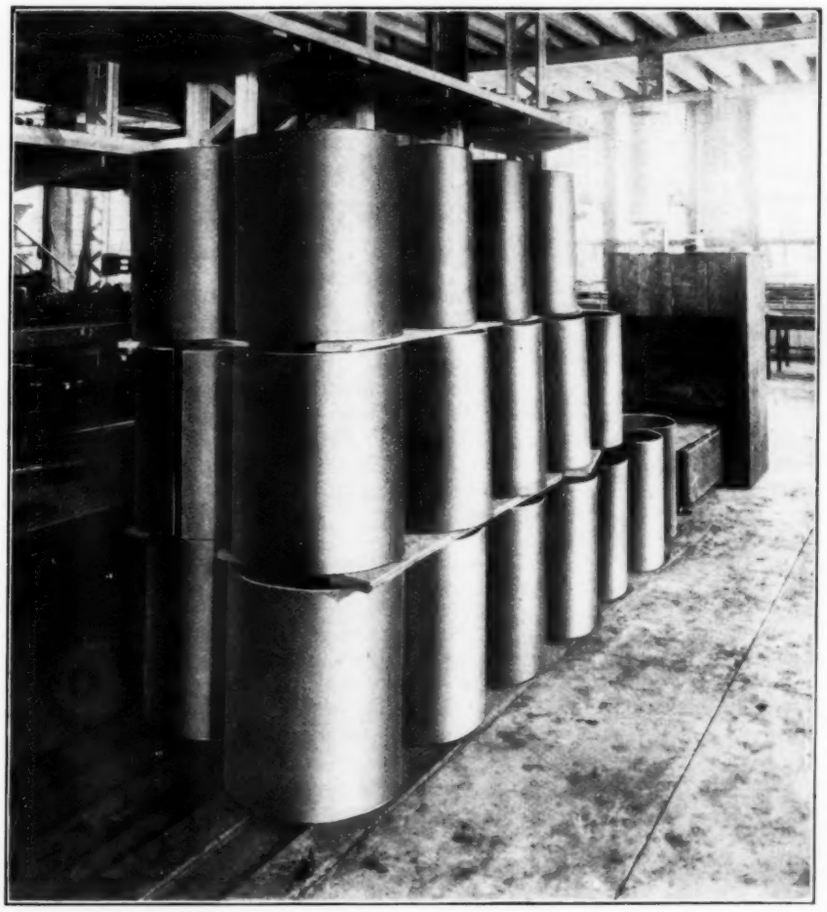


FIG. 6. A LOT OF ROLLED SHEETS.

Many persons seem to think that writing for publication makes life one glad sweet song. If you are one of them, ring off! You have got the wrong number. If you write jokes, people say you are rattle brained; if you philosophize or moralize, people will say you are a fossil and won't read your stuff. If you write original matter, they say you don't give them enough selections; if you give them selections they say you are too lazy to write; if you don't go to church, you are a heathen; if you do you are a hypocrite; if you remain in the office, you ought to be out looking for news; if you go out you ought to be at home attending to business; if you wear old clothes, they laugh at you; if you wear good clothes, they say you are stuck up. Now, what are you to do? Just as like as not some one will say I stole this from another publication. So I did—I got it from *"The Optical Journal,"* who got it from the *"American Correspondent,"* who admits he copied it from the *"Wyoming Derrick,"* and I don't know where the *"Wyoming Derrick"* got it.

Variation of Pressure in Bearings Due to Eccentric Loading.

At the New York meeting of the American Society of Mechanical Engineers in December, 1905, there was some attention paid to the matter of eccentric loading of bearings by Geo. R. Henderson in his paper on locomotive bearings. This subject appears to have been much neglected by technical writers, nor is very widespread or extended notice in engineering books and periodicals given to the subject of eccentric loading of columns, which has an analogous mathematical treatment. We should be glad to hear from any of our readers who have some information to offer upon this topic, and as a starter we publish a diagram sent by M. A. Beck, of Milwaukee, Wis., devised to readily show the effects upon bearings of eccentric loading or of unsymmetrical supports.

Mr. Beck states that the conditions leading to rapid wear and trouble are much worse than the diagram indicates, and that its chief value lies in showing quickly how greatly the pressure varies with even a slight shifting of the load line; the fact should not be lost sight of that much the same condition of things is brought about in a bearing which is apparently evenly loaded, but in which deflection takes place, either in itself or in the journal. An ample discussion of this matter should bring in the hydrodynamic laws governing the behavior of a film of oil when subjected to the varying conditions of supply, pressure and motion.

The following is the notation employed in the diagram and formulas:

a is the distance from the point of application of the load, or center of pressure or support to the nearest end of the bearing. It may be called the length of the short end.

d is the diameter of the journal.

L is the length of the journal or bearing.

P is the total pressure, or support reaction, divided by the projected width of the bearing (which may be *d*).

P_1 is the unit pressure at the short end of the bearing.

P_2 is the unit pressure at the long end.

The ratio $\frac{a}{L}$ varies from 0.5, for a bearing loaded in the center, down to 0 for a bearing loaded at one end. The diagram gives values of P_1 and P_2 in terms of the mean pressure. When the distance of the center of load from the short end is equal to one-third the length of the bearing, or in other words when $\frac{a}{L} = \frac{1}{3}$ as is the case with the force *P* located as shown in the cut, the pressure on the long end becomes zero, and when *a* is still further reduced the pressure on the long end becomes negative, that is it acts in the opposite direction.

The manner of using the diagram is pretty evident: The line of action of the force *P* is produced downward until it intersects one of the sloping lines (as at *m*). The abscissa corresponding to this ordinate gives the value of the pressure at the nearest end of the bearing in terms of the mean pressure. To find the pressure at the other end, draw a horizontal line through the point of intersection *m* until it intersects the other sloping line at *n*; the abscissa of this point gives the required ratio. The numerical values of the abscissas increase right and left from the zero point (beneath the point *n* in the diagram).

The diagram is based on the following formulas, which express the same relations as that given in Mr. Henderson's paper, though the notation and form of the expression are a little different:

$$P_1 = \frac{P}{L}\left(4 - \frac{6a}{L}\right)$$

$$P_2 = \frac{P}{L}\left(\frac{6a}{L} - 2\right)$$

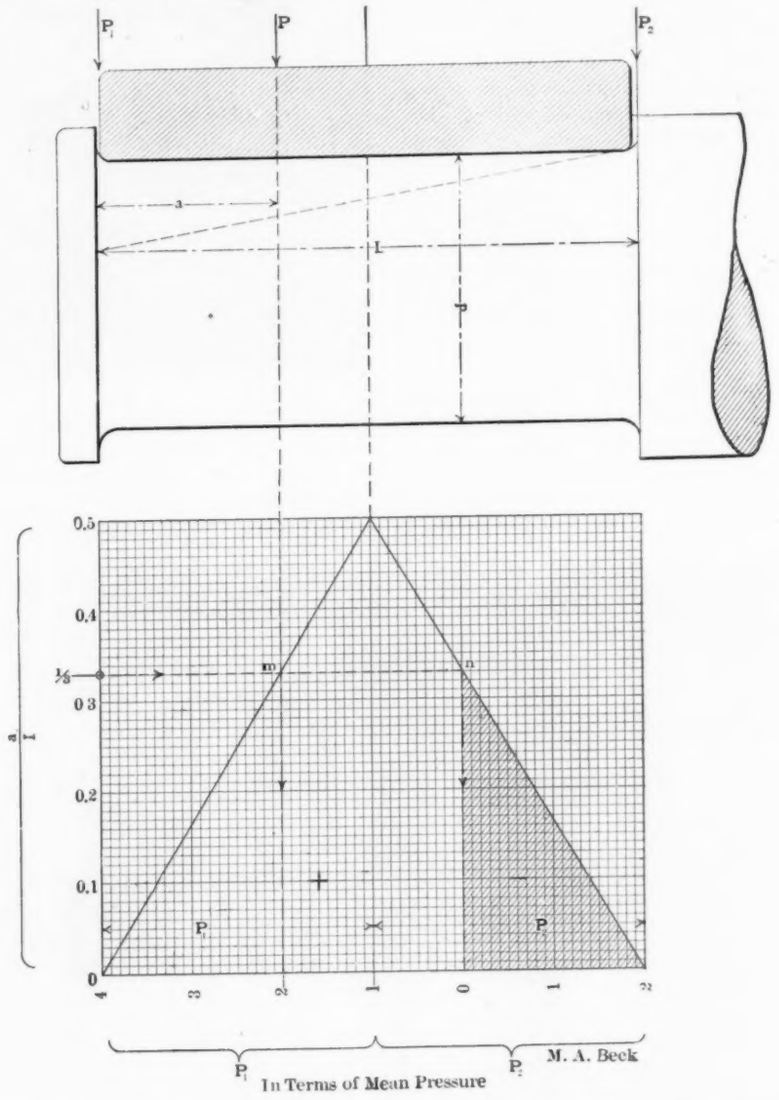


DIAGRAM SHOWING VARIATION OF PRESSURE IN BEARINGS DUE TO ECCENTRIC LOADING.

A Historic Locomotive.

By the courtesy of the Pennsylvania Lines an interesting locomotive has been added to the collection in the museum of Purdue University. The engine, of which the name is "Ruben Wells," was built in 1868 by what was then the Jeffersonville, Madison & Indianapolis Railway, to surmount the incline from Madison, Indiana, which, previous to the construction of the engine, had been a cog road. The designer of the engine, from whom it was named, made a careful analysis of the conditions and decided that a locomotive working by adhesion alone and having all its weight on the driving wheels would do the work and this engine was the result. There were originally five pairs of coupled driving wheels of 49 inches diameter driven by 20x24-inch cylinders. The two rear driving wheels, which were originally under the tank which was arranged much after the plan of the Forney engines, were subsequently removed and

the tank was placed over the boiler. The engine was an excellent adaptation of means to an end and in its early days was looked upon as a machine of remarkable capacity.

The Jhelum River Hydro-Electric Power Installation in British India.

A large hydro-electric power installation is to be made on the Jhelum river in Kashmir, in northwestern India, near Rampur. It is planned to develop 20,000 horse-power, the head of water being about 400 feet. The gravity conduit line will be 34,000 feet long, the upper 8,500 feet consisting of an excavated ditch lined with masonry, the remainder being a rectangular flume, or wooden stave pipe. The pressure lines will be of riveted steel pipe 790 feet long, of diameters ranging from 54 down to 30 inches. The power house is to have 12 main units and three exciter units; the former each containing a 1,000-kilowatt alternator, running at 500 revolutions per minute, direct-driven by a Doble tangential water-wheel delivering 1,765 brake horse-power. The brake horse-power of the exciter units will be 285; these also being driven by water-wheels at 500 revolutions.

The power house will be of solid masonry, with a wide veranda and a double steel roof on account of the heat from the tropical sun. Concrete is not used on account of the prohibitive cost of cement, portland cement costing $7.50 per barrel delivered at the site. Fortunately there is plenty of natural rock in the neighborhood.

Among the uncommon engineering conditions met with was the necessity for transportation by bullock carts over 200 miles of roads, including a lift over a mountain range 8,000 feet high. For this reason the maximum weight of any single piece of machinery when packed was limited to 4 tons.

The contract for hydraulic equipment is held by the Abner Doble Company, of San Francisco, California. One important use which it is proposed to make of the electric power is to operate the 180-mile Kashmir section of the Jhelum Valley Railway, in all probability by means of a single-phase traction system.

According to the report of the U. S. Commissioner of Patents, in 1905 there were received 54,034 applications for mechanical patents, 781 design patents, 156 reissues of patents, 16,224 applications for registration of trade marks, 1068 labels, and 467 prints. There were 30,270 patents issued, including designs. The total receipts were $1,806,758; expenditures, $1,479,633. Last year 16,224 applications were received for trade-mark patterns, while in the preceding year only 2524 were filed.

Letters to the Editor.

A Dog with Two Tails.

As will be seen by the accompanying illustrations this relates to a lathe dog and the question is quite likely to come into the minds of most lathemen: "What does a lathe dog want two tails for?"

The practice in this country is quite at variance with that of other countries. We use a crooked-tail dog because it is much more simple and more convenient to operate than the other kinds.

In foreign practice, it may be said to be the universal practice to use a straight-tail dog and either use a single pin projecting from the face plate to drive it, which is a better practice than ours, or in many cases where they desire the best results they have two pins and adjust one so as to have it hit the set screw when the other hits the tail, thus driving the piece to be turned without any tendency to spring it and effectually preventing chatter.

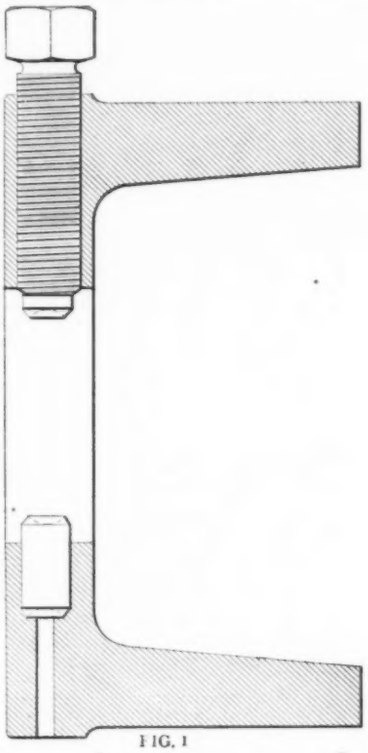


FIG. 1

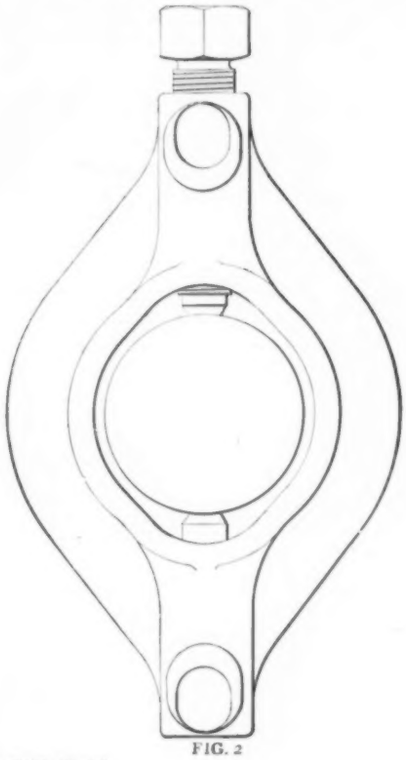


FIG. 2

A DOG WITH TWO TAILS.

Clement, an accomplished draftsman of three-quarters of a century ago, devised an arrangement whereby the two pins in the face plate were self-adjusting, being fastened in a supplemental face plate arranged to slide across the regular plate until both pins struck the dog.

Charles S. Beach invented and illustrated in the MACHINIST a dozen years or so ago, a dog in which the sliding plate was on the dog instead of on the face plate. While I am not aware that it was ever put on the market, one of the best lathe men in the Straight Line Engine Works always uses the one he has, on work it is suited for.

The Landis Brothers Machine Company furnish one of another sort for their grinders which has features whereby it can be kept in balance for high speed and delicate work, but it is somewhat complicated.

In the Lo-Swing lathe, Mr. Hartness has introduced a driver which is intended to accomplish the same end, by the twisting pin. Though that is a part of the lathe instead of the dog, it suggested the device here shown.

It will be seen by Fig. 2 that the piece to be turned is grasped by the point of the cupped center of the set screw and a fixed center opposite and is free from the sides of the dog, which leaves it free to turn so that if one tail of the dog strikes first it can twist until both drive equally.

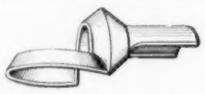
The thing is as easy to handle as the ordinary dog, as in putting it on, it allowed to twist as it has a tendency to do when screwing up the set screw, it centers itself. After it is set tight straighten it back and if the two horns only get in the slots of the face plate it will set itself.

The question will at once come into the mind of the reader, why not put in two set screws? Because the "duffer" will crowd in too large a bar or let back one screw so the bar will hit the sides of the dog and destroy its usefulness. In the hands of a careful man the two set screws would be best as they would give a chance to hold a wider range of sizes.

JOHN E. SWEET.

Bevel-Gear Guard.

In looking through the advertisements in a recent number of the AMERICAN MACHINIST I found several illustrations of upright drills where the bevel gears at the top of the spindle were exposed and only one where they were covered, and this one was not so much advertisement of the drill as of a motor drive. Now it seems to some of



A BEVEL-GEAR GUARD.

us that these gears are really dangerous when unprotected.

When a fellow with his eyes on his work goes groping around in the air after the feed lever he is likely to get his fingers nipped, especially if he is working on a strange machine where the handle comes in an unfamiliar place. A great many years ago a pattern was made at our shop like the accompanying sketch and all the drills were fitted with these covers. The pattern molds easily without any cores and has smooth easy curves so that brass castings may be easily polished and when in place add quite a smart touch to the machine. Isn't it up to the manufacturer to build his machine so complete that the purchaser will not have to improve a whole shopful?

W. H. S.

Another Large Job on a Small Lathe.

The casing *A*, an end view of which is shown at *B*, was recently delivered at the Knickerbocker Machine Works, 8 Jones street, New York. After being deposited on the second floor it was discovered that the six holes *C*, which were to have been machined before delivery at the shop, were as they came from the foundry. The casting was 6 feet long, 4 feet high and 3 feet wide—not the easiest thing in the world to handle; so it was decided to rig up a make-shift and do the job in the shop.

The lathe shown in the illustration is twenty-four inches swing, one of the largest in the shop.

A sleeve shown at *E* was bored 1 15/16 inch and keyseated its full length, as shown. A piece of 1 15/16 inch straight cold-rolled shafting *F* was then obtained, a groove *G* was turned near one end and a key fitted in the shaft three or four inches from the groove *G*, so as to be a free sliding fit in the keyway in the sleeve *E*.

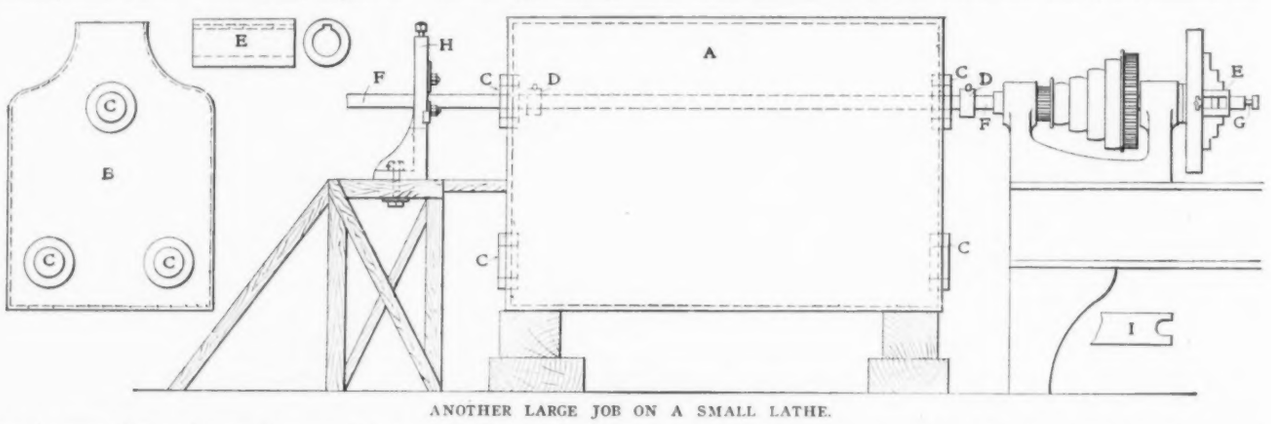
The casting *A* was then blocked up on timbers at the rear of the headstock, as shown, and a platform built for the steady rest *H*. When the casting *A* was approximately in position, the sleeve *E* was caught in the chuck, as shown, and centered. The boring bar *F* was passed through the sleeve *E*, through a bushing fitting the rear end of the spindle, and also through the two upper holes *C* in the casting *A*. Before putting it through the steady rest *H* two collars *D*, which carried adjustable cutters, were slipped on. The bar was then passed through the steady rest and set in line. The casting *A* was then wedged into position and after bracing thoroughly with wooden shores to prevent it moving, was ready for boring.

A yoke *I*, shown under the bed of the lathe, was made of a piece of machine steel of suitable size to fit the tool-post of the lathe. The jaw in the end fitted the groove *G* in the end of the boring bar.

The cutters on both collars *D* were then set to the proper cutting depth. With the yoke in the tool-post, and engaging the groove in the boring bar, the lathe was started up, boring both holes simultaneously, the carriage of course doing the feeding. The holes *C* were about five inches in diameter by about three inches long. The bosses had to be faced on the outsides. To do this a hook-shaped tool was forged to rough a ring about half an inch wide at each cut, taking three cuts in all to rough each end, which was eight inches in diameter. The faces were then finished with a wide tool taking the whole 1½ inch width of cut.

The lower holes *C* were finished in the same way in a perfectly satisfactory manner, both as regards time and accuracy.

DIXIE.



ANOTHER LARGE JOB ON A SMALL LATHE.

Machining a Shaft with Eccentric End.

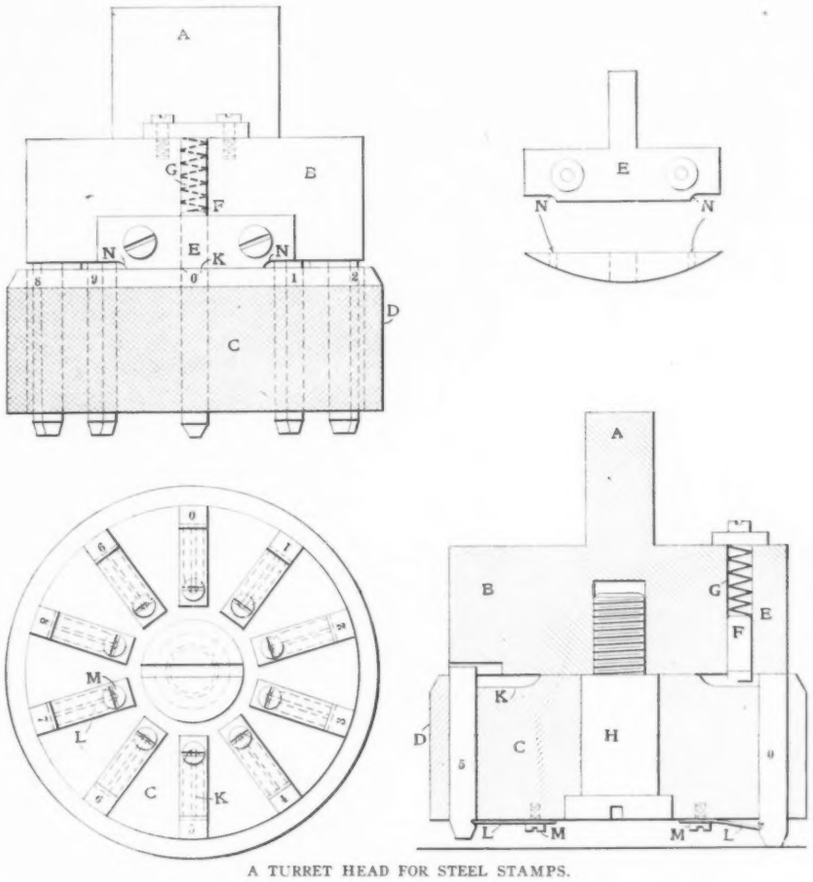
The drawing shows a shaft 17-32 inch diameter, the small end of which is threaded and has its center offset 7-64 inch from that of the large part. The shaft is required to be hardened and ground the entire length of the large diameter, the eccentric end being soft. It is necessary also that the small end run practically true upon its own center.

The method by which this shaft was first produced in quantity was such that the small end was invariably found to be bent out of line with its axis, requiring expensive straightening. This method was essentially as follows: Each shaft was cut from stock 1-32 inch larger than the finished piece, centered and turned in a small lathe adapted for the purpose, by means of a series of hollow mills. The eccentric end was afterward turned down and threaded in a lathe in the ordinary way, after which the hardening and grinding were done. As a result of the hardening, the stem was always "out of true" and considerable time was necessarily spent in straightening.

THE SHAFT TO BE MACHINED.

To avoid this difficulty and expense, and to reduce the other costs of manufacture, a new method was tried. Cold-rolled and drawn steel of a diameter varying from 0.010 to 0.012 inch above the finished size was used. After being cut into the proper lengths, the steel was put into a furnace, heated to a low heat and then allowed to cool slowly so as to remove all surface strains caused by the rolling. Each piece was then carefully centered in a screw machine, after which it was made ready for hardening. This preparation consisted in covering the end of each piece with a gray-iron cap of the exact length of the turned stem and packing the capped piece in granulated bone. After being heated

for a sufficient length of time to give the proper depth of treatment, the box was taken from the furnace and kept in a nearly vertical position while being emptied. Each shaft was taken out with its axis vertical and dipped so as to prevent any bending from its own weight. When cool, the centers were carefully lapped, and the body of the shaft ground exactly to the required size. The shaft was then ready for its final operation which was the turning and threading of its small end.



A TURRET HEAD FOR STEEL STAMPS.

The turning was done by holding the shaft in a special collet in an ordinary screw machine and using the common screw-machine tools. The collet was made in the usual way, the hole, of course, being eccentric. The work was located in the collet by means of a screw which passed through the nose piece and collet into the key-way in the shaft.

When the work was slipped into the open collet the screw was set down gently into the key-way. The collet was then closed and the screw tightened hard against the shaft, after which the stem was turned and threaded. The results were very satisfactory, the method being a decided improvement over the old one both as regards quality and cost of product.

L. A. MURRAY.

A Turret Head For Steel Stamps.

Some years ago, having a number of articles of various dimensions to stamp with figures, I designed the turret head shown in the illustrations.

It was fitted to a Dwight slate marking machine. The body *B* was machined so as to form the rectangular shank *A*. After turning, drilling and tapping the hole in the center, the side was machined to accommodate the pawl *F* and the hammer *E*. The turret head *C* was made of machine steel, a snug turning fit on the central shoulder screw *H*. The periphery was slotted to accommodate the ten characters from 0 to 9 inclusive. Ten indexing notches *K* were then milled in it. A machine-steel ring *D* was then shrunk on. This ring was nurled to give a good hand-hold while indexing from one figure to another. It was also beveled on top as shown and the characters contained in the adjacent slot marked thereon for convenience when indexing. The sides of the indexing notches *K* are at an angle of about 45 degrees, so that the indexing pawl *F* will lift without excessive force being applied. The hammer block *E*—made of tempered tool steel—is fitted in, and held with two screws as shown.

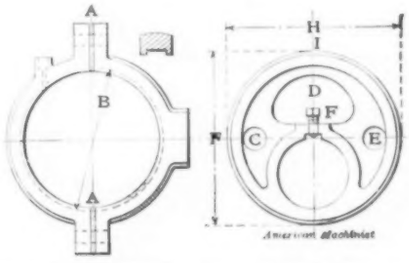
A notch is filed in the lower end of each character to accommodate the spring *L*. The operation of the device is this: Suppose it is desired to mark *O*—as shown in the section. The nurled ring *D* is grasped and turned till the mark *O* on its beveled face is opposite the center of the hammer *E*. The pawl *F*, forced down by the spring *G*, indexes the character *O* in correct position. It will be noted that there are two beveled faces *N* on the hammer. As the characters advance toward the center of *E* they strike this incline which is about 1/16-inch high. The character to be used is thus forced, against the pressure of the spring *L*, 1/16-inch in advance of the other characters, so that when the machine is tripped that character only which is wanted is stamped into the article to be marked; the others being raised by the springs *L* when they pass the incline *N* as shown in the section.

EDWARD WEHRHAHN.

Boring Eccentric Straps—Faulty Design of an Eccentric Sheave.

When boring eccentric straps for large steam engines, on the boring mill, we find the following method to give very good results, and far preferable to any other we have tried during several years' experience.

When the two halves of the strap are



BORING ECCENTRIC STRAPS—FAULTY DESIGN OF ECCENTRIC SHEAVE.

planed across the joint and ready for bolting together for boring, insert a piece of sheet iron about 1-32 inch thick in each joint as shown at *A A* and bolt the strap together. When boring to size at *B*, first set the gage the size of the finished sheave and then get a piece of sheet iron, the same thickness as those in the joints, and place it between the end of the gage and the work. This will give you the diameter of the sheave plus thickness of one piece of sheet iron. When the pieces of sheet iron are taken out of the joint, the hole will not be exactly round, being 1-32 inch smaller in horizontal plane than it is vertically. This gives the oil a chance to lodge in at top and bottom and insures far better lubrication.

Talking of eccentrics reminds me of a case which came under my notice some time ago on a 400 horse-power Corliss steam engine. Our usual method of fastening these on the shaft was by a hard fluted saddle key, and a 1¼ inch set-screw, with a hardened point—shown at *F*—so that the eccentric could be moved on the shaft at any time, to allow the lead of the valve. *C* and *E* are two holes, about 2 inches diameter, cored in the web as shown, to allow a bar to be put

through for moving the eccentric on the shaft. *D* is a cored hole for a wrench to operate the set screw *F*. After we had the eccentrics fastened in position, and tried to get the straps on, we found that one of them—the high pressure—was far too tight to work. We could not understand this, as we knew they were all "ground in" at the shop. When calipered we found the dimension *F* nearly 1-32 inch larger than *H*. To make the strap turn freely—when bolted up tight—we had to file nearly 1-32 inch off at the point marked *I*. When we slackened the set-screw, we found to our astonishment the dimension *F* was much smaller than *H*; it then dawned upon us that we had sprung it oval, by tightening the set-screw *F*. The low pressure eccentric being heavier than the high pressure had not been affected. Although we had been using this type of eccentric for several years, this was the first case of springing we had come across. We have slightly altered the design now to get over the difficulty. CORLISS.

England.

Should a Machinist Sit While Working?

Referring to H. T. M.'s contribution, "Should a machinist sit while working?," at page 675, Vol. 28, Part 2, a few years ago I took charge of the machine shops of a prominent concern, as general superintendent. There had been no rules forbidding workmen sitting while working, provided they accomplished their work equally well. In looking over the shop I found nothing had been provided for them in the way of stools. Boxes, nail kegs, etc., were utilized for this purpose, and a few of the more progressive men had made themselves something resembling a stool or had bought one. I had the foremen make me a list of the men that could make use of stools and ordered enough to go around, of various heights to suit the requirements of the workmen. I instructed the foremen to distribute them among the workmen, at the same time saying to them that we much preferred them to use the stools, while their machines were under a cut, rather than have them leaning up against the bench or leaving their machines to visit fellow workmen. The workmen appeared pleased with the stools, and the shop took on a more orderly appearance at once.

As in all cases, a few took a mean advantage of the privilege, and they were promptly disciplined.

I always worked on the principle that if a workman did not appreciate my efforts to make him comfortable and happy at his work, he was not the kind I cared to retain, and quietly dispensed with him.

I took note of the result from time to time and was very well satisfied. Not only was the shop more orderly, but there was less spoiled work, and better work. I retained a better class of workmen and had no labor troubles whatever.

E. E. WOOD.

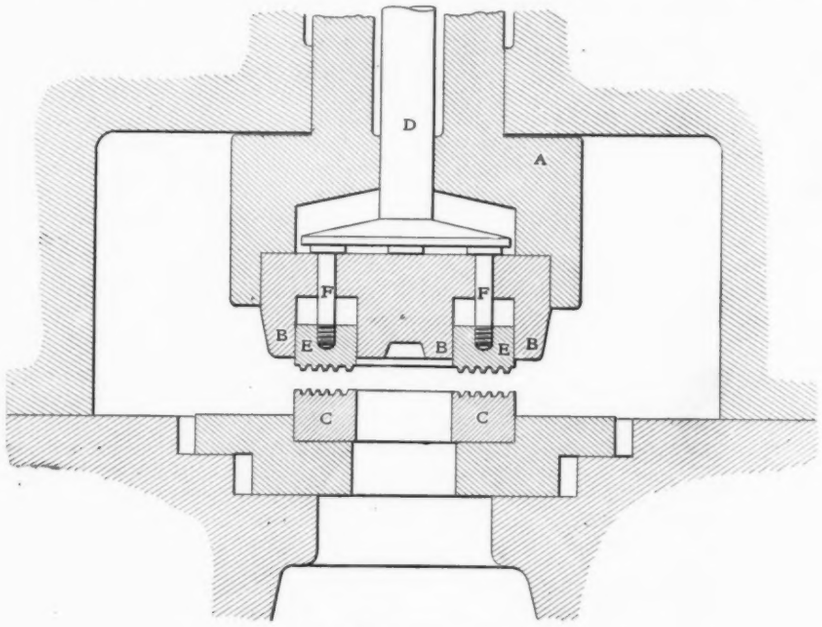
Genl. Mgr. Geo. D. Walcott & Son,
Jackson, Mich.

Making Corrugated Copper Gaskets.

In continuation of what I said at page 890, Vol. 28, part 2, regarding Dixie's machine for making corrugated copper gaskets, I submit herewith a drawing of a punching and forming die which I saw employed in a German machine shop.

The female part of the die is carried by the plunger, and is composed of a cutting die and a forming ring; while the male die is supported by a centering plate or bolster on the frame of the press.

The press as shown is in the position



DIE FOR MAKING CORRUGATED COPPER GASKETS.

of starting, and works thus:

First, the sheet of copper is fed between the dies, then the plunger *A* begins its downward movement until the cutter *B* reaches the cutting edge of the former and cutter *C*. The knockout *D*, which is operated by an independent lever, remains stationary until the former *E* reaches the bottom of the cutter *B* when it is carried down by the plunger *A* which, following a downward course, forces the forming parts together.

On the upward stroke the knockout *D* is stationary for a while, until the plunger *A* in rising, forces the stops *F* to come in contact with the end of the knockout *D* forcing the former *E* to push out the corrugated gasket which has been contained in the cutter *B* during the forming operation. Then the knockout *D* is carried up by the plunger *A* during the remaining part of the stroke.

The center, which is cut out by the cutter *B*, will drop through the hole in the middle of the die.

This press is very positive and was in operation about five years ago. I would not be surprised if such presses are to-day substituted by automatic feed presses based on the same principle.

T. BARRA FRAUENFELDER.

Reducing the Thickness of Long Keys.

Referring to page 889, Vol. 28, Part 2, AMERICAN MACHINIST, in an attack entitled "Reducing the Thickness of Long Keys," signed by "Cameron," in which he indulges in a little sarcasm, at the expense of "Texas," I would like to say that the article written by "Texas," and printed at page 291, was not written with the idea of helping anyone of such marked ability as himself, but for the benefit of those less fortunate persons, who might not have had his experience. I think it would be advisable for Mr. Cameron to read that little article again, and perhaps it might not appear so amusing. In the first place, Texas did not do any planing on those keys, but distinctly states that the job was turned over to the vertical millers after the planers had fallen down on it. He did not say that the vertical miller was the only machine that would do the job, but that it was the best machine to do it on. Mr. Cameron states that Texas did not mention the kind of stock, but that anyone could easily guess what he was planing by his apparent surprise at the big bow in the key after the first chip. Evidently Mr. Cameron forgot to put on his glasses when reading this article, as the greatest surprise would have been, if the stock had not curled up after the first chip. Instead of losing sight of the fac-

that both sides were milled, before obtaining any good results, that was the very point I was trying to make clear, namely: that after one side was milled, the stock curled up, presenting a concave surface. On turning the key over, and taking a chip from the opposite side, thereby removing the strain and allowing the first side to resume its normal condition, this brought the concave surface on the second

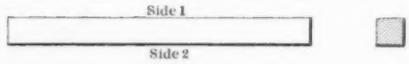


FIG. 1

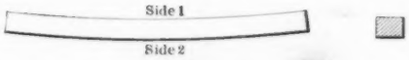


FIG. 2

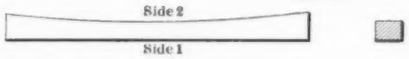


FIG. 3

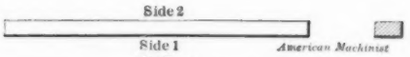


FIG. 4

REDUCING THE THICKNESS OF LONG KEYS.

side, requiring a finish chip to make both sides parallel. The following sketches, (not to scale) may illustrate more plainly my meaning.

Fig. 1 represents the stock before milling.

Fig. 2 represents the piece with the first chip removed showing concave surface, only exaggerated.

Fig. 3 shows the piece when a chip has been taken off side 2 allowing side 1 to resume its normal position.

Fig 4 shows the key after side 2 receives the finish cut.

Now, while I inferred that part of the result was due to the action of the cutter being sideways of the stock, it remains an open question, as to the cause, which I would like to hear discussed by others. I contend that in planing the strain is unevenly removed, inasmuch as the cut removed is the entire length, and the strain is gradually removed from one side to the other, a little at a time, allowing stock to wind and twist. This was acknowledged by our planer-hands, who are among the best, and although they have a natural dislike of millers, they were obliged to acknowledge the corn. Hoping that this may make things plainer, I would like to call attention to Mr. Cameron's closing sentences, in which he writes: "I have found that the scale or hard surface on flat or square cold rolled stock, varies in depth and sometimes nearly a thirty-second can be removed without releasing the strains and then again that amount from the second side would cause it to bow up; this seems to show that the scale is deeper on one side than on the other." I am glad that he uses the word seems as that allows other people a chance to know something about it too. The fact that the stock bows up after the second cut, is not on account of the scale being thicker on one side than on the other, but as shown in these sketches, is caused by the stock resuming its normal position, after the strain is removed from the second side. If, as Mr. Cameron claims, the scale is thicker on one side than on the other, how does he account for the stock being straight to start with? Where it is really as he says, the side with the thicker scale would assume a convex shape, and force the weaker side into a concave. Again he claims that the trouble would be avoided by annealing the stock. This is poor practice as regards cold-rolled stock, inasmuch as the stock is soft enough, and in annealing the chances of the sizes altering are very good, besides destroying the finish. Of course, I will admit that if time and money are of no account, this job could have been done in other ways; but were that the case, we would not have used keystock at all, but machined the keys out of forged steel. TEXAS

Crank Shafts for Triplex Pumps.

Let it be desired to find the diameter and length of the center crank pin, C, for a double acting pump, when the net load on one piston, P, is given.

From the table find the simultaneous bending and torsion moments for which the pin should be figured.

$$M_b = \frac{a+2b}{a+b} \times a \times P$$

and

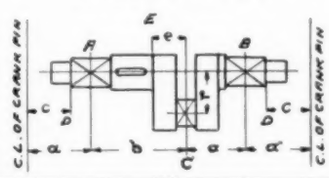
$$M_t = 0.87\,\frac{a+2b}{a+b} \times r \times P$$

Then find the ideal bending moment

$$(M_b)_i = \tfrac{3}{8}\,M_b + \tfrac{5}{8}\sqrt{M_b^2 + M_t^2}$$

Decide upon the allowable working

STYLE OF SHAFT



FORMULAS

FOR STRENGTH

$$Z = \frac{(M_b)_i}{S}$$

$$d = \sqrt[3]{\frac{32\,Z}{\pi}}$$

FOR PRESSURE ON BEARINGS AND PIN

$$\frac{R}{d \times l} = Q$$

SEE NOTE UNDER l.

Z = SECTION MODULUS

$Z = \frac{\pi d^3}{32}$ FOR CIRCULAR SECTIONS

FIND Z AND THEN THE DIAMETER REQUIRED FROM TABLE BELOW.

— SECTION MODULUS = Z —

	0/0	1/8	1/4	3/8	1/2	5/8	3/4	7/8
2	.785	.945	1.12	1.31	1.53	1.81	2.05	2.33
3	2.65	3.00	3.39	3.78	4.21	4.75	5.13	5.73
4	6.28	6.86	7.50	8.20	8.95	9.68	10.3	11.4
5	12.3	13.2	14.6	15.1	16.3	17.4	19.0	19.9
6	21.2	22.5	24.0	25.4	27.0	28.5	30.2	31.8
7	33.4	35.5	37.4	39.3	41.4	43.5	45.7	48.0
8	50.3	53.8	55.0	57.5	60.3	63.0	65.9	68.8
9	71.6	74.6	77.2	80.1	84.2	87.5	91.0	94.0
10	98.2							

$(M_b)_i$ = IDEAL BENDING MOMENT IN IN. LB.

$(M_b)_i = \frac{3}{8}M_b + \frac{5}{8}\sqrt{M_b^2 + M_t^2}$

M_b = BENDING MOMENT IN IN. LB.

M_t = TORSION " " "

BENDING AND TORSION MOMENTS AT DIFFERENT SECTIONS FOR WHICH THE SHAFT SHOULD BE FIGURED

SECTION		S. A. PUMPS	D. A. PUMPS
A AND B	M_b	$a \times P$	$a \times P$
	M_t	$r \times P$	$r \times P$
C	M_b	$a \times P$	$\frac{a+2b}{a+b} \cdot a \cdot P$
	M_t	$0.87 r \cdot P$	$0.87 \frac{a+2b}{a+b} r \cdot P$
D	M_b	$c \times P$	$c \times P$
	M_t	$r \times P$	$r \times P$
E	M_b	$a \cdot P$	APPROX $1.4\,a\,P$
	M_t	$0.87 r \cdot P$	$1.74 r \cdot P$

P = NET LOAD ON PISTON IN LBS

a-b-c-e IN IN. SEE FIG

r = HALF THE STROKE IN IN.

S = WORKING STRESS IN LBS PER SQ. IN.

S = 8000 LBS FOR STEEL CASTING

S = 10,000 " " " FORGING

d = DIAM. OF SECTION IN IN.

R = MAX. REACTION ON BEARINGS AND PIN IN LBS

	BEAR. A	BEAR. B	PIN C
S. A. PUMP	$\frac{3a+2b}{a+b} \cdot P$	$2P$	P
D. A. PUMP	$\frac{4a+2b}{a+b} \cdot P$	$\frac{3a+2b}{a+b} \cdot P$	P

NOTE. THE CAP STUDS ON MAIN BEARINGS SHOULD BE FIGURED FOR THIS MAX. REACTIONS.

Q = ALLOWABLE SURFACE PRESSURE IN LBS PER SQ. IN. OF PROJECTED AREA

Q = NOT MORE THAN 450 LBS FOR BEARINGS

Q = " " " 600 " " PIN

l = LENGTH OF BEARINGS OR PIN IN IN.

NOTE. THE LONGER THE BEARING IS, THE COOLER IT WILL RUN. — AS LONG AS THE PROPER LIMIT FOR THE SURFACE PRESSURE IS NOT EXCEEDED, AN INCREASE IN DIAM. WILL NOT CONSIDERABLY AFFECT THE HEATING OF THE BEARING — AS A ROUGH GUIDE MAY BE USED THE FORMULA

$l = 0.000065 \cdot f \cdot R \cdot N$

f = COEFFICIENT OF FRICTION

f = 0.10 TO 0.12 IS SAFEST TO USE FOR MAIN BEARINGS, TAKING IN CONSIDERATION DEFECTIVE WORKMANSHIP, IMPERFECT OILING, ETC.

f = 0.08 TO 0.10 MAY BE SAFE TO USE FOR THE CRANK PIN ASSUMING PROPER OILING ANYTHING LESS THAN f = 0.08 IS LIKELY TO CAUSE TROUBLE AND SHOULD BE AVOIDED IF POSSIBLE

N = NUMBER OF REVOLUTIONS PER MIN.

0.000065 = COEFFICIENT INCLUDING AMOUNT OF FRICTION WORK PER SQ. IN. OF PROJECTED AREA

NOTE. IN ORDINARY CASES IT IS SUFFICIENT TO MAKE THE WIDTH OF THE CRANK ARMS ABOUT $\frac{3}{4}$ DIAM. OF PIN

NOTE. ALL CORNERS SHOULD BE GIVEN AS LARGE RADIUS AS POSSIBLE

CRANK SHAFTS FOR TRIPLEX PUMPS WITH CRANKS AT 120 DEGREES.

stress S and find the required section modulus for the pin

$$Z = \frac{(M_b)_t}{S}$$

Then find the diameter from the formula

$$d = \sqrt[3]{\frac{32\,Z}{\pi}}$$

or from the table of section moduli for diameters from 2 to 10 inches for each eighth of an inch.

The maximum reaction on the pin is from the table.

$$R = P$$

The length of the pin required is then found from the formula

$$\frac{R}{d \times l} \leq Q$$

It may also be advisable to consider the length of the pin in reference to the note given in the table under l = length of bearing or pin in inches. H. G.

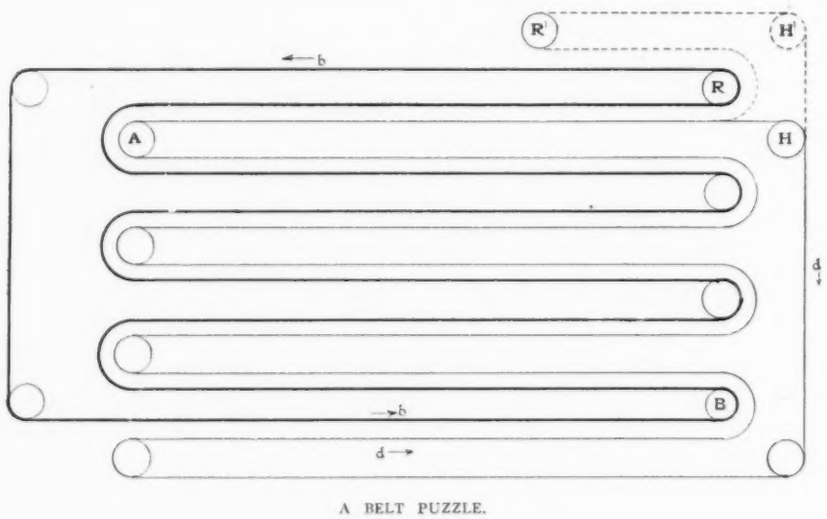
A Belt Puzzle.

I should like to suggest the following explanation of the belt puzzle presented at page 62 by Charles E. Schumacher. It will be noticed in the accompanying diagram, copied from Mr. Schumacher's, that the number of pulleys over which the two belts run together is the same on each side, with the evident expectation that they will neutralize each other so far as the movements of the belts are concerned. The difficulty arises from the fact that the belts are elastic. In the diagram let us notice pulleys A and B, disregarding for the time being the intermediate pulleys. The two belts on leaving the pulley A are not moved with the same velocity; the belt b being carried by a larger diameter runs slack between the pulleys A and R, while the belt d between A and H will be, say, normal in tension. Now notice what takes place at B. Here the belt b running on the surface of the pulley is carried at a less velocity than d. This results in producing a slackness in the belt b all the way from the pulley A around to the pulley B, for the reason, as noticed, that the belt b leaves the pulley A at a high velocity, while it is taken up by B at a low velocity. For a like reason the belt d is in tension from the time it leaves A until it is taken up by B. It is this looseness that causes b to travel faster than d.

I would suggest that if the number of pulleys on the right hand side be made one greater than that on the left hand, the difficulty may be overcome. For example, let the belt d be passed around pulley R, then over R^1, then over H^1, which is the same as H lifted high enough to cause the return belt to clear the pulley R. It will be noticed that an arrangement of this kind causes the belt b to leave the pulley R on its surface and hence at a low velocity, while it is being taken by the pulley B on the surface and hence at a low velocity. This will keep its tension uniform. At the same time the belt d leaves the pulley at a high velocity and is taken up by the pulley B at the same velocity; hence its tension will be uniform.

If the theory is correct, this arrangement should give the same velocity of travel for the two belts. I should like very much to hear from Mr. Schumacher the result of a trial of this kind, if he sees fit to make it.

REYNOLD JANNEY.

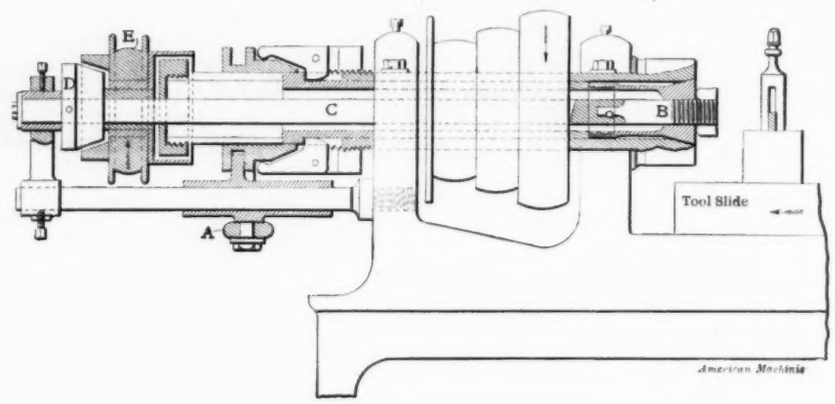


A BELT PUZZLE.

Attachment for the Nut Facer.

The sketch shows an attachment for facing semi-finished cold pressed nuts or any class of work requiring to be screwed on and off a threaded mandrel, without stopping the machine or taking the mandrel out of the chuck.

We had occasion to face large quantities of nuts and a good up-to-date nut facing machine, but found the process a little too slow for the quantities required to keep up with the other machines in the department. So I devised this rig to help us out. Now the way that the machine came to the works required the operator to take the arbor out every time he finished a nut, screw the nut off and another on by hand, then put the arbor back in the spring collet and pull up tight with the lever A. The output was from 2,000 to 2,500 ½ inch nuts per day of ten hours; with this small attachment it is possible to face semi-finished nuts at the rate of twelve nuts per minute, or from 5,000 to 6,500 in ten hours. The device has been in operation long enough to be past the experimental stage and is giving the best of satisfaction. It is much easier on the operator as the nuts do not now cut the hand.



ATTACHMENT FOR NUT FACER.

B is a toughened steel arbor fitted into driving rod C by means of a small taper pin. There are several arbors and they are made interchangeable so that they may be used in collets from ¼ to 1¼-inch. Now when the operator pulls the hand lever the chuck grips tight on the arbor, and the latter runs in the direction of the arrow on the cone pulley. The operator starts the nut on the end, runs it readily up to the face of the chuck, then brings up the facing tool and faces the nut; then when he releases the arbor with the hand lever, he carries it back until the cone D engages small pulley E which revolves fast in the opposite direction and the driving rod C then causes the nut to run off the arbor without any wrench being

necessary except in cases where it is too small for the arbor, and then the least touch with a tool or wrench will release it.

Toronto, Ont. W. LOACH.

Coring in Name Plates.

The accompanying illustrations show a method employed in placing name plates upon engine beds, etc., and one which insures their non-removal except by chipping. The method consists of a slab core of any form made from a core box upon the bottom of which is the desired lettering. Fig. 1 shows the core print, in this case of an elliptical form, and secured to the pattern by two loose dowels of different diameter as shown, in order to avoid placing the core print in the reverse position. A marker *B* is also required upon the print and in the core box, to insure placing the core in its correct position in the depression left vacant by the core print. Fig. 2 shows the general arrangement of core box which is parted on the lines *C C* and *D D*. The frame or print portion *E* having been gotten out to conform to the core print shown in Fig. 1, it is placed upon the bottom board *F* and secured with dowels, and its elliptical outline is scribed thereon. The surface enclosed by this outline is now backed out or depressed to the required depth *G* (which is usually the thickness of metal letter used) and the metal lettering is attached in the ordinary manner.

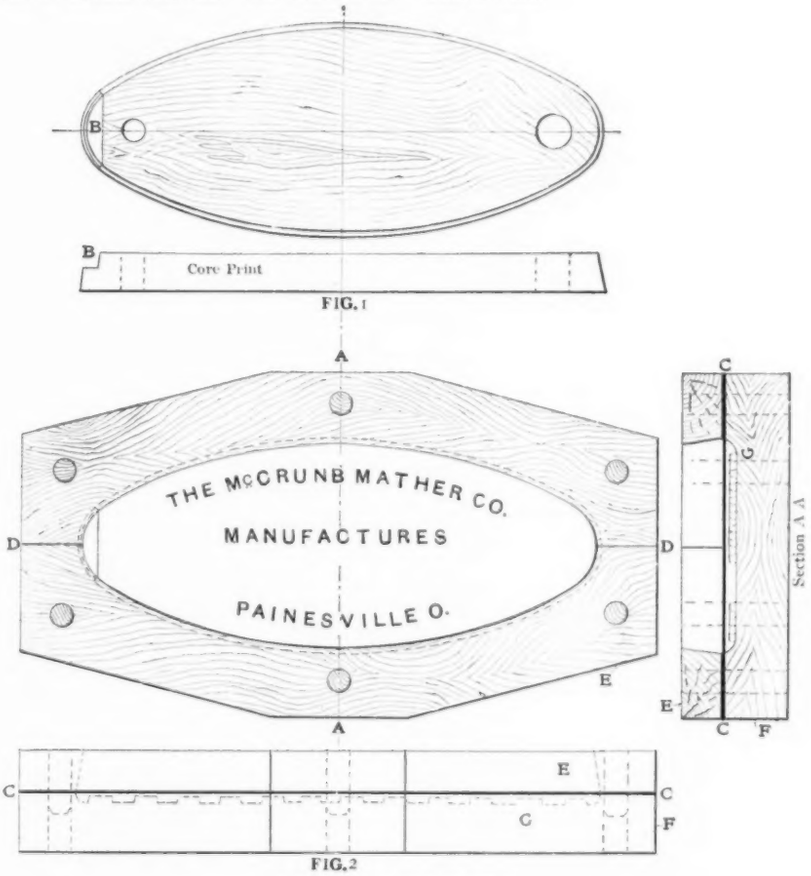


FIG. 1

FIG. 2

CORING IN NAME PLATES.

H. H. MCCASLIN.

A New Drawing Instrument.

The combined inventive talent at the works of The Straight Line Engine Company has evolved the little handy device shown in Fig. 1. It is for drawing round corners and fillets of various sizes and for those purposes it is far more convenient than compasses; radii are marked, the outside ones made enough smaller and the inside ones enough larger so that corners when drawn with a pencil or inking pen will be the size indicated. They can be of various other radii and if the draftsman wishes to mark what the radius of his curve is, he has the figures before him.

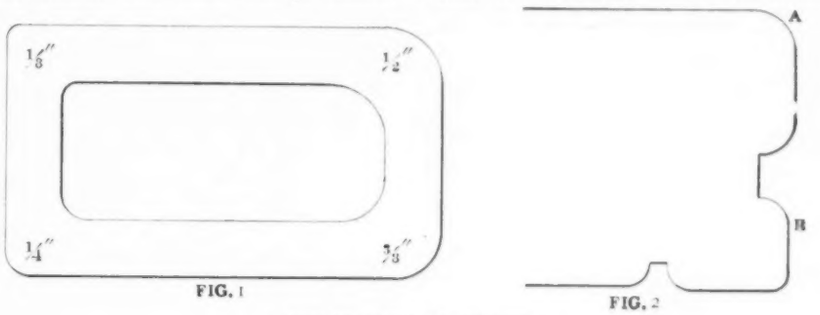


FIG. 1

FIG. 2

A NEW DRAWING INSTRUMENT.

The instrument may be of any sheet metal nickel-plated or of celluloid and if 1/12 inch thick, beveled on one side, used flat side down for the pencil and the other side for the inking pen it will be found a great convenience.

Fig. 2 shows its application, the curves *A* and B being drawn by using the outside corners and the others by using the inside.

JOHN E. SWEET.

Our English readers have already been made familiar with certain facts set forth in an English Government report entitled "Gain Sharing and Certain Systems of Bonus on Production." Our American readers dealing with these things will be interested to know that for calculating the bonus a reference rate is taken instead of a standard time. If the amount earned in time wages, including overtime, falls short of the reference rate, the balance is divided equally between the employers and the employed. It will be seen that this is essentially the Halsey system, with the modification that the workman is at very slight advantage in working overtime. On the other hand, the working of overtime entails but a slight increase in wages on the part of the employer. The ratio of bonus paid to wages received varies largely with the class of workmen, and apparently grinders, erectors, smiths and strikers reap the greatest advantage. Still, as only an insignificant number of erectors and smiths appear to be employed on the system, it is hard to make a definite statement. However, a number of turners and machinists are thus engaged, and here the ratio mentioned is roughly between 50 and 60 per cent. Taking all classes of engineering workmen, the bonus has varied between 24.1 per cent. in 1895 and 41.2 per cent. in 1903, the maximum occurring in 1900, when the ratio was 42.3 per cent. Not including draftsmen, foremen, timekeepers and storekeepers, the total number of workmen employed in 1903 was 934, of whom 494 worked on the system mentioned. Still not the whole of the latter number were employed all the time on the bonus system, the amount of time wages received by the men while on the system being equivalent to 51.8 per cent. of their total time wages in respect of the whole of the work done by them in the year. In short, roughly, 250 men were employed throughout the year on the bonus system.

In the petrol-engine cylinder, the highest temperature reported is in the neighborhood of 4000 deg. F. This is at the hottest portion of the exploding mixture of gas and air.— *The Engineer.*

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The index to Part 2 of Vol. 28 (for last year) is ready for distribution, and has been sent to all who are on our mailing list. It will be sent free of charge to anyone who asks for it. Your name and address on a postal card with the word "index" will bring it by mail.

Watered Stocks and Monopolies.

So many railroad officials seem to take it for granted that because they understand the railroad business they also understand better than anyone else the political and economic questions connected with the railroad problem (in spite of the fact that they have evidently given little or no attention to the study of these questions), that it is somewhat refreshing to find one who has evidently studied these matters somewhat, and such a one is A. D. Stickney, president of the Chicago Great Western railroad, who favors (reservedly) legislation on the subject of railway-rate regulation, but in speaking of the "watering of stock," Mr. Stickney utters some wholesome truths which ought not to be lost sight of. He calls attention to the fact that, judged by the same standard as is applied to railroads and other public franchise companies, any rise in value above the price originally paid for the property is "water," and says that American farms are largely "watered" in that way; that is to say, they pay interest on a valuation far above what was originally paid for them, and nobody seems to object to this.

Although at first the two cases may not seem to be parallel, we yet believe that they are really so, and we believe that any company owning property, whether based upon a franchise or not, ought to have the undoubted right to sell as much stock as it chooses to people who are willing to buy it at the price fixed, and who are enabled to know all the facts concerning it that they need to know in order to buy intelligently. The fact is that when stock offered for sale seems likely to pay a fair dividend, based upon the price at which it is offered, then there is no good reason why such stock should not be sold and purchased, no matter if the total issue of stock does greatly exceed the cost of reproducing the plant, or the railroad, or whatever it may be that it pertains to. Shares of stock are properly based upon the value of a business and upon its capacity to earn money; not upon the mere cost of the four walls of a building, with the machinery within the building, nor upon the cost of railway embankments, crossties, steel rails and rolling stock.

The vital question with regard to all these matters is the question of a monopoly; that is the thing which concerns the public. If the business is by its nature monopolistic; if it is such that there can be no such thing as free and open competition in it, then the interest of the public in such business becomes acute; but so long as such a monopoly does not exist, we cannot see that the public has any concern with the amount of stock sold, nor with the alleged profits made in the business, so long as such profits are honestly made. Mr. Stickney, by the way, recognizes the fact that a railroad is necessarily and by its nature a monopoly; but he believes that the railway monopolies are much less objectionable and have worked far less harm than other monopolies; for instance, the land monopoly, about which comparatively little, he says, is heard.

End of the Work of an Industria Organizer.

Birmingham papers just to hand contain an account of the death of E. J. Smith, an account of whose plan of organization for unifying the interests of manufacturers and their workmen, and securing fair profits and wages for them, we published in our issue of February 15, 1900, and at pages 612 and 613 of Vol. 28, Part 2. Mr. Smith at the time of his death had become a notable personage in the industrial circles of Great Britain, and although some of the organizations formed by him have not proven permanent, others, we understand, are still flourishing, and it seems not unlikely that the principles introduced by him in these organizations will have an important influence in similar or analogous associations.

The particular association which he first organized in Birmingham, and which related to the metal bedstead trade, encountered special difficulties from the fact that the prices fixed for the product, and which were such as to afford fair compensation to the workmen with a fair profit to the manufacturer, met strong foreign (especially Spanish) competition; and also the manufacturers of tubing, such as is used in the construction of bedsteads, formed an association of their own, and of course this resulted in a considerable increase in the prices paid by the bedstead manufacturers for their raw material.

Had the bedstead manufacturers retained their confidence in each other, however, they could, of course, have organized their own tubing mills, and thus have been independent of the other organizations; but such perfect confidence, or at least such confidence as was necessary to the smooth working of the association, seemed to be lacking, and there were those who believed that the prices fixed or prescribed by the association were not always adhered to, but that they were sometimes shaded by the members in their too strenuous pursuit of orders.

Of course, after all, all such associations must in the final analysis be an effort to raise those who participate in them above the general economic level prescribed by the free play of the law of supply and demand, and unless such an organization is supported by an actual and genuine mono-

poly, that is a monopoly of such a nature that it prevents free and open competition, it is exceedingly difficult to evade or counteract the effect of that law. This was successfully done for a term of years to the advantage and profit of both the workmen and the manufacturers in Birmingham, and is, we understand, being now done in other places in Great Britain. The fact that it was done will, of course be a strong incentive to repeated effort to accomplish the end sought, and these successive efforts will naturally be made in full view of the difficulties which have developed in the management of such organizations, and with the intention of avoiding them; with what success, time can tell. At any rate it can be said for Mr Smith that his work has been along original lines and has produced a very considerable effect upon the industrial life of Great Britain.

New Publications.

"Les Aciers Spéciaux." Second volume. Chromium, Tungsten, Molybdenum, Tin, Titanium, Vanadium, Aluminum, and Cobalt Steels. By Leon Guillet, Doctor of Sciences, Engineer of Arts and Manufactures, with a preface by Henry Le Chatelier. 132 9x11¼-inch pages, with numerous illustrations. Vve. Ch. Dunod, Quai des Grandes Augustins 49, Paris.

M. Henry Le Chatelier's indorsement of this work should alone suffice to win for it an attentive reception. In the preface he classes M. Guillet's researches with those of Sir Lothian Bell on blast furnaces, and of Mr. Hadfield on special steels, characterizing them as one of the most brilliant manifestations of metallurgical science. The present volume, relating to the varieties of steel above named, follows one on silicon, manganese and nickel steels. It is a reprint, in French, of matter published during 1904 and 1905, in the *Revue de Metallurgie*. The steels in question have been studied in various conditions, such as those raw from the forge, hardened, etc., and have been subjected to micrographic examination, tensile, fragility, and hardness tests, etc. Samples have been chosen with a variety of carbon percentages, and with quantities of the alloy metal reaching as high as 30 per cent. or more. The particular significance of this series of tests seems to lie in their scope and system, which afford a basis for bringing out of chaos and treating coherently such seeming anomalies of physical properties as are sometimes found in alloy steels. The author has drawn many conclusions from his results.

Arsenic is really a metal, but represents the dividing line between a metal and a non-metallic substance.

First Annual Convention of the National Supply and Machinery Dealers Association.

This convention was held at the Hotel Chamberlin, Fortress Monroe, Va., February 14, 15 and 16. The attendance was quite large and the meeting was enjoyed by all present. The first session, Wednesday morning, was an open one to which all were invited; and after the singing of the hymn "America" and prayer by Rev. Chas. S. Walkley, Chaplain Artillery Corps, U. S. Army, the president of the association, E. E. Strong, read the following address:

THE PRESIDENT'S ADDRESS.

At the close of our first year as an association it seems proper to ask in brief what have been the results and what are the prospects for the future.

The details of the past year you will have from the report of our efficient secretary. I think it proper, however, to call your attention to the fact that owing to the necessary delay in perfecting our organization and determining upon the selection of a secretary, the year's work has really all been done in eight months. Considering the conditions existing last June, I believe that exceedingly satisfactory results have been accomplished, and that there is every reason to expect that during the coming year the association will take such a position that there will be no question as to its importance and value both to its members and the manufacturers with whom it works.

On the first of June, 1905, we had enrolled only about forty members and it was thought advisable that our secretary should spend the necessary time to increase our membership before attempting to do much work with the manufacturers.

The attitude of the manufacturers was not at all encouraging. Many of them were jealous of one another and most of them were distrustful of our association. In a great many instances they had the mistaken impression that we were organizing to fight them instead of combining to work in greater harmony with them. As far as I know, or am able to learn, this mistaken impression has been entirely done away with and a good many of the manufacturers are beginning to look to the association as an aid in adjusting matters between themselves as well as between themselves and their customers.

This feature alone is very encouraging; but we must not be too impatient for immediate results. All business is more or less in a rut, and it requires some little time as well as effort to get it out. Most of those of us who built our own business from the ground up will remember that the first year or two, and perhaps three or four, were not very productive of bank accounts, and that we felt highly encouraged if we could see that gradually matters were coming our way. In accordance with the views of the association a number of manufacturers have adopted a resale price. This plan has been followed for some time by certain manufacturers in the hardware line, at the suggestion and solicitation of the National Hardware Association, and has been found very satisfactory. It only needs the enthusiastic support of our association to induce manufacturers generally to adopt the plan. I am so well satisfied of its importance that I urge all members to give it support when offered. Several manufacturers who have decided on this plan have advised me that there seemed to be but little interest taken in it by our members.

If this is owing to unfamiliarity with the plan, or opposition to it, I hope that it will be thoroughly threshed out before the convention.

I would urge upon the convention the value of local associations, both for their intrinsic value to members and their aid to the national association. I find that where there is a good local organization it is easy to bring a strong influence to bear upon any question that arises, as well as being highly beneficial in dispelling incorrect ideas of our competitors. Locally we should know each other better than we do, and that in almost every case will result in our being better friends and having more confidence in each other.

I would suggest that during the coming year members take it upon themselves as a duty to the association to bring to the attention of the secretary such matters as may occur to them as proper for action by the association. During the past year but little of this has been done by the association generally.

The business outlook seems in the highest degree promising, and united, persistent efforts on our part promise better reward for our labors in the future than in the past.

Upon the completion of the reading of the president's paper, W. M. Pattison and J. H. Drury, both of Cleveland, were presented with silver loving cups as a token of the esteem in which they were held by the association, Mr. Pattison having been the secretary of the organization during its early formation and Mr. Drury the secretary-treasurer for the past eight months.

INFORMAL DISCUSSION.

During the Wednesday morning session there was informal discussion by various members and supply manufacturers of the "re-sale" price question, which question it was announced would be considered more at length at a later session. This was one of the points taken up in the president's address, and its discussion indicated a desire upon the part of members to have fixed prices established at which dealers should sell to customers without undercutting in this or that case.

The importance and helpfulness of local organizations were mentioned by various speakers; and the retiring secretary, J. H. Drury, and others suggested that members

could help the association greatly by systematically looking after suggestions, complaints etc., and forwarding items of value to the new secretary, A. T. Anderson.

The afternoon session was taken up mainly with routine business.

RESOLUTIONS.

On Thursday there was further discussion behind closed doors of the re-sale price question and the matter of cash discounts was considered; the following resolutions were presented by Mr. Puchta and adopted: "Resolved that the Convention of the National Supply and Machinery Dealers' Association heartily endorse the action of the manufacturers who have shown their disposition to co-operate with us.

"Be it further resolved that the members of this association support such manufacturers in every practicable manner to encourage and establish its policy."

On Thursday afternoon an open meeting was held at which there was a considerable attendance of manufacturers as well as dealers, and several of the manufacturers present spoke and expressed their willingness and desire to co-operate with the dealers along the desired lines.

Later, A. E. Brion read the following set of resolutions, which were adopted by the convention:

"Whereas, we oppose the present agitation to make the use of the metric system compulsory as it entails unnecessary expense and inconvenience upon manufacturers and dealers in machinery and supplies.

"Therefore, be it resolved that we, the National Supply and Machinery Dealers' Association, in annual convention assembled, and the manufacturers here represented, respectfully urge upon the Congress of the United States that the optional legislation now in effect concerning the use of the metric system is sufficient for all practical purposes.

"Resolved, that the secretary be directed to forward copies of this resolution to the proper committee of Congress and to the publishers in the *New York Herald*."

ELECTION OF OFFICERS.

The business of the convention was practically concluded Thursday afternoon with the election of officers, the officials for the past year all being re-elected with the exception of past secretary-treasurer, J. H. Drury, who is retiring from the dealers' association shortly to engage in manufacturing. The officials for the coming year are therefore: President, E. E. Strong, Cleveland, Ohio; first vice-president, W. A. Somers, Pittsburg, Pa.; second vice-president, Alfred Marshall, Chicago, Ill.; secretary-treasurer, A. T. Anderson, Cleveland, Ohio.

THE BANQUET.

A good many of the delegates to the convention were accompanied by their wives, and on Wednesday evening a ball was given in the Hotel Chamberlin; this being followed Thursday evening by the annual banquet of the association, at which there was a large attendance, both the banquet and the speaking that followed being much appreciated by all present. George D. McIlvaine, of Pittsburg, presided as toastmaster. An interesting feature was a talk by Chaplain Walkley of the Artillery Corps, on fair play. President Strong and other members spoke of the work and aims of the association, and the secretary, A. T. Anderson, gave an address on the duties of the business man as a citizen.

Friday, the last day of the meeting, was devoted to sight-seeing and visits to various points of interest in the vicinity of Fortress Monroe, a number going to Norfolk in the morning, and visiting the plant of the Newport News Shipbuilding and Dry Dock Company in the afternoon.

Information Wanted About Mutual Benefit Associations.

We have received from the Department of Commerce and Labor, Bureau of Labor, Washington, D. C., a letter by Chas. P. Neill, commissioner, in which he says:

The Bureau of Labor is preparing a report covering the various systems of workingmen's insurance and employers' liability, both in this country and abroad. The report will cover insurance against sickness, accident, disability, old age, death, and unemployment.

In this connection it is endeavoring to secure information concerning the existence in the United States of what are usually known as establishment funds—that is, mutual relief or insurance funds organized and maintained by the employees of an industrial establishment, or relief funds supported either wholly or in part by the employers themselves. It is desired to obtain, wherever possible, copies of constitutions, rules and by-laws, blank certificate forms, and any other matter relating to funds of this character. In the absence of other data the name and location of establishments in which such funds exist are desired.

In view of the wide circulation which your journal has among employers of labor and others who may be in a position to furnish information regarding this subject, I would esteem it a great favor if you would insert in an early issue of the same a brief mention of the above facts, with the request that persons possessing data of any kind relative to the existence of establishment funds in this country communicate with me at their earliest convenience.

The commencement of construction on the Erie Railroad was commemorated by a monument dedicated, on November 10, at Deposit, N. Y. The monument is set on the spot where the first shovel of earth for the construction of the Erie was dug.

A Standard Size Wanted for Business Cards.

BY W. OSBORNE.

As many things can be just as well done any one of several ways, and as some of these ways may give trouble we try to have standards adopted.

Standards are simply labor saving devices. At first it is only the very great and important thing that is standardized, and this because the necessity for it is very plain and the saving very great, or it may be the trouble caused by the lack of standards is so universal that many people are ready for anything that saves them annoyance.

I have never had experience in having standards adopted outside of my own work, and I hardly know how to go about having one adopted by the rest of the world, but I would like to see a standard card adopted by traveling salesmen. It is often very convenient to save these cards, and it would be so much easier done if they were uniform. It is not of so much importance to the old established firm who has been having its man come in regular year after year, but when that new fellow shows up and tells me a lot of fairy tales which are interesting because of being new, but do not seem to apply to my case I kept his card, likely with sundry little notations on it so that I can remember part of what he told me. Along with others of the same kind I put it away. Week after next I want his house address, which I did not take or try to remember at the time for I did not have the faintest idea that I should ever want any of their stuff, and I begin to hunt for that card. It is somewhere among my collection, or else it went into the waste basket. If it was one of these large affairs on which the firm tries to put their entire catalog and previous history in such a way that it cannot be cut down to a size that will go into my filing tray it likely went into the waste basket, and if it was one of those little flimsy affairs about 5⅛x1 11-32 and .00425 inch thick it is more than likely wadded up some where in the bottom of the tray or else sticking close to the back of some thick card where it will escape all ordinary search.

What I should like is to have a 3x5 card used for all firm announcements. These cards would fit into the ordinary desk drawer trays and could be readily handled, and would be worth much more to the firms using them, because they would be much more apt to be kept. Some firms now use cards of this size and I have known of cases where they got business because these cards had been filed while those of their competitors, being of some inconvenient size, had not been. When goods were wanted in their line the card brought back the claims of their salesman while the other one was not thought of.

For the personal card of the salesman with which he wishes to announce his presence in places where he is well known, to the end that he may be permitted to pass in to the buyer, the 3x5 size is too big and for this purpose I would suggest the 2x3. If they are made smaller than this they are hard to handle, and if they are much larger they are an offense to the esthetic taste of many salesmen.

From the shop office to the maker of cards is a long kick, and the only way I see to deliver it is through the user of the card. If the user calls for a standard size and the maker advises it in cases where his opinion is asked we will have it, and it will be better than the dozens of sizes now in use. If they were all made of the most inconvenient size in the lot it would be better than the present state of the art.

I have heard others growling about this matter, but perhaps owing to its seeming insignificance, the growling was not done in public.

Perhaps there are other sizes that would be better than those suggested. If so I hope they will be brought forward and pushed until they become recognized as standard. The day should come when a firm would no more think of using an odd size of card than they would of using an odd size of catalog, or an odd size pipe thread.

As the Irishman said when he was fighting the mosquito; "'Tis not the size or the danger of the thing that I object to, but it is the waste of time, and the distraction which it produces."

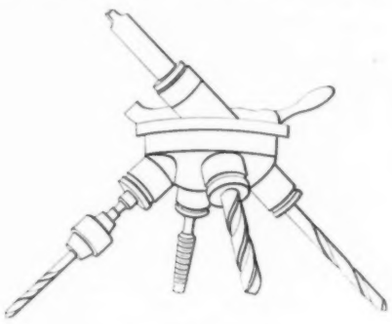
New Typewriter for the Blind.

Consul-General Guenther, of Frankfort, on the authority of the Frankfort Didaskalia, reports that Mr. Dussaud, a Frenchman who has rapidly become known through a number of important practical inventions, has invented a new typewriter for the blind, of which it is expected that it will revolutionize the writing of blind persons and enable them to write and read in the same manner and under the same conditions as those who can see. They will, in future, also need only a single alphabet instead of two, as heretofore. The apparatus is supplied with a row of keys, and if one, two, or more of these keys are pressed down with the fingers, the desired letters or the desired word appears. This new typewriter with keys is by far the most perfect instrument which has ever been offered to the blind for writing. It can be rapidly operated and furnishes a regular writing that the blind can easily read. Another advantage of special importance is that the lines cannot run into each other. Tests have been made at the Ecole Braille for the Blind, at Paris, which have given the greatest satisfaction.

New Tools and Machine Shop Appliances.

A TURRET LATHE.

The illustration shows a turret head, applicable to drill presses, boring machines, lathes, etc. It is so designed that all the tools except the one in use are stationary.



A TURRET HEAD.

The shank is fitted to the spindle of the machine in which it is to be used. The latch is tripped and the turret is swung until the desired tool is in line with the machine spindle. The latch is then released. It locks the turret in position and throws a clutch which transmits the motion of the machine spindle to the socket holding the tool. This turret head may be used for tapping as it drives in either direction equally well. It is manufactured by the Power Specialty Co., 513 Washington Arcade, Detroit, Mich.

A VARIABLE SPEED GEAR.

The illustrations show a new form of variable speed gearing, applicable to drill presses, etc., for which a patent has recently been granted to Emil A. Hoefer of the Hoefer Manufacturing Company, Freeport, Ill.

Referring to Fig. 1, which shows a part of a drill press equipped with this type of gearing, *A* is the worm wheel on the feed shaft, *B* is a worm mounted upon a vertical shaft shown also in Fig. 2, which is a section through Fig. 1 at *XX*. Upon the top of the vertical shaft a worm gear *C* is secured. Meshing with *C* is a worm *D*, mounted on a horizontal shaft *F*. Three gears *G H I* are keyed to this shaft. The gears *G H I* mesh with the gears *J K L* loosely mounted on the stationary shaft *M*. By referring to Fig. 3 the gears *J K L* may be seen shown in

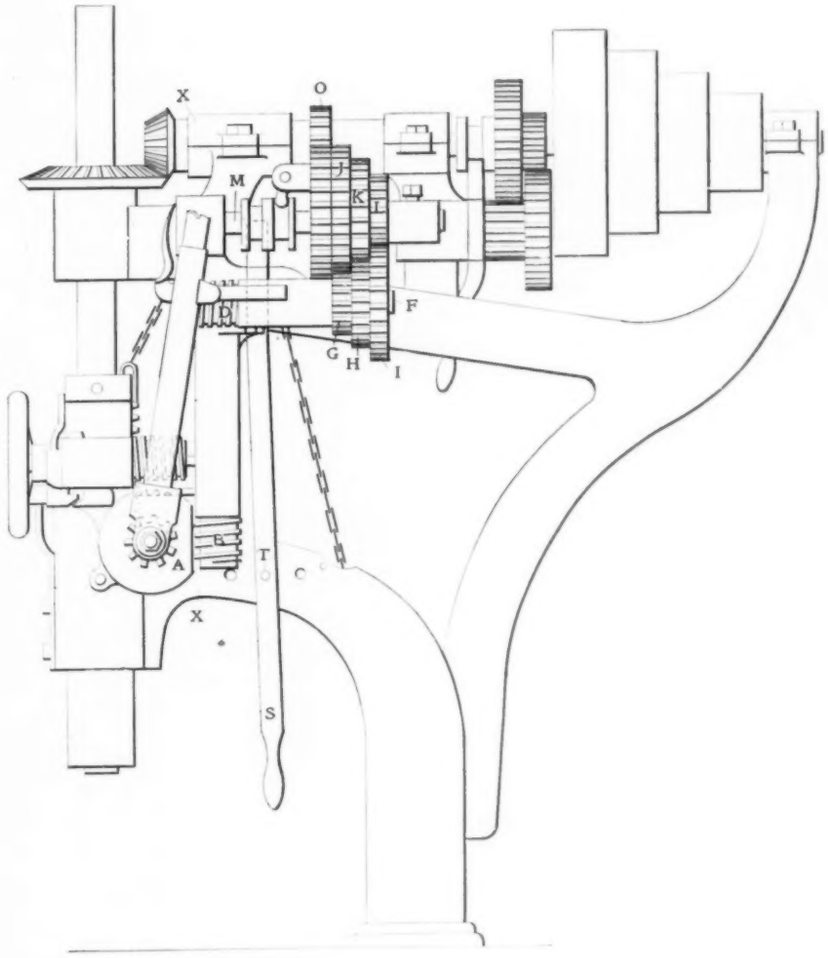


FIG. 1. GENERAL ARRANGEMENT OF THE VARIABLE GEAR.

section. Mounted on the shaft *M* is the gear *N* which is driven by the pinion *O*. (See Fig. 1) The gear *N* is provided with

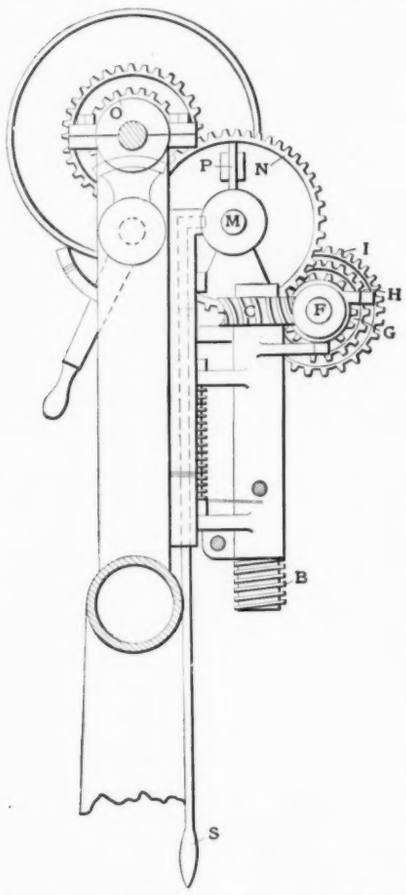


FIG. 2. SECTION THROUGH FIG. 1 AT XX.

lugs which carry the bell crank *P*, one end of which works in a slot in the gear *N;* the other end engages the flanged clutch collar *Q*. Fig. 4 shows the gears *J, K* and *L* in section, disassembled, and also an end view of the assembled gears. The gear *J* is provided with four lugs *R*. *K* and *L* have two lugs *R* each. By referring to Fig. 1 it will be seen that the position of the flanged clutch collar *Q* is controlled by the lever *S*. The lever *S* has a locking pin hole *T* in it, which coincides with a series of stop holes in the frame. When the lever *S* is thrown to the extreme left the flanged clutch collar *Q* is shown to the extreme right. This lifts the end of the bell crank *P* and engages

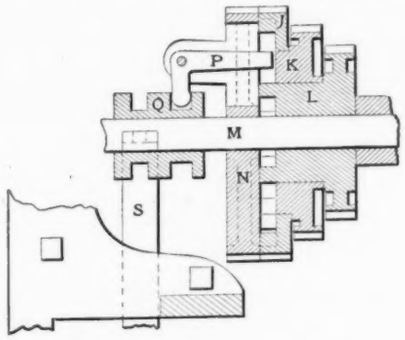


FIG. 3. THE CLUTCH GEARS AND PAWL.

it with the lug *R* on the gear *J*. Moving the lever *S* one hole to the right engages the bell crank with the lug on *K*. Moving the lever *S* one hole further to the right engages the lug on *L*, while moving *S* to the last hole to the right disengages the bell crank from *L* and permits the gear *N* to rotate without imparting any movement to the gear train *G H I*. The position of the end of the bell crank *P* when out of gear with all of the gears *J K L*, is shown in Fig. 4 at *P'* by the dotted lines.

A PNEUMATIC WRENCH.

This tool is intended to be used in connection with an ordinary pneumatic or electric drill for screwing nuts on or off. The chuck that turns the nut is provided with an adjustable friction which is adjusted to suit the nut to be operated on.

The nuts to be tightened are placed on the bolts with about 1 ½ turn, the tool will run them up to the surface and tighten them, then the friction arrangement will take up the jar and allow the drill to continue rotating while the wrench-chuck itself remains stationary.

This tool has been thoroughly tested at th shops of the Central Railroad of New Jersey, at Elizabethport, and found to work remarkably well. It has been found however, that a ¾-inch nut is the maximum capacity, not of the tool itself, but of the drill, as the largest drill is not strong enough to develop power to tighten a 1-inch nut sufficiently tight.

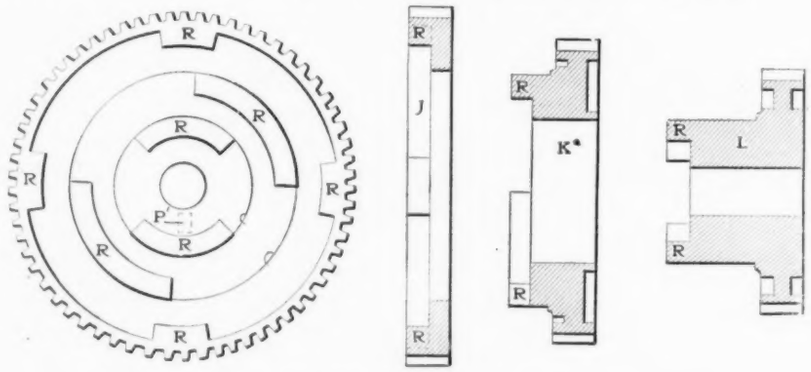
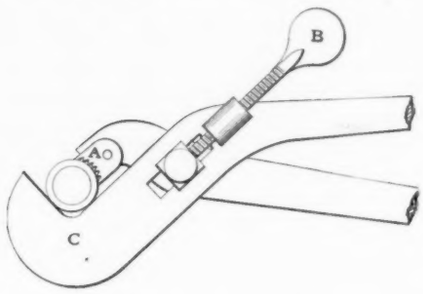


FIG. 4. SECTION AND END VIEW OF THE CLUTCH GEARS.

This tool is made by A. E. Hoermann, 261 Broadway, New York.

A PAIR OF PIPE TONGS.

The illustration shows the jaw end of a pair of pipe tongs. These tongs are quickly adjusted to size by the screw *B*. The V-shaped jaw *A* and the jaw *C* give four points of contact on the pipe. It is claimed for this style of tongs that they



A PAIR OF PIPE TONGS.

will neither crush nor chew the pipe. They are made in three sizes, taking pipe from ⅛ to 2 inches, inclusive, by Thomann Brothers, Riverside, Iowa.

Clearance Allowances for Bearings.*

BY JOHN W. UPP.

Supplementing the topical discussion on bearings and believing it will be of interest to the society to have the practice of one of the leading manufacturers of electrical apparatus outlined, below please find a list of clearance allowances for bearings ⅛ inch to 24 inches:

Journal Dimensions.	Bore.	Journal Dimensions.	Bore.
⅛	.377	6	6.009
¼	.502	7	7.011
⅜	.627	8	8.012
½	.752	9	9.013
⅞	.877	10	10.014
1	1.002	11	11.015
1⅛	1.128	12	12.016
1¼	1.253	13	13.017
1⅜	1.503	14	14.018
1¾	1.753	15	15.019
2	2.003	16	16.020
2¼	2.253	17	17.020
2½	2.503	18	18.020
2¾	2.754	19	19.020
3	3.004	20	20.020
3½	3.504	21	21.020
4	4.005	22	22.020
4½	4.505	23	23.020
5	5.006	24	24.020
5½	5.507		

TABLE OF CLEARANCES FOR HORIZONTAL BEARINGS.

The Bulletin of the American Chamber of Commerce, No. 44, contains the Twelfth Annual Report of the Board of Directors and also the report of a special committee, charged with the investigation of matters pertaining to treaties of reciprocity. The Chamber endorses strongly such efforts as have been made here for reciprocal trade arrangement, and expresses the hope that we shall come to a better understanding and recognition of the principles enunciated by President McKinley in his last address on the relations between the

*Contributed to the discussion on bearings at the New York meeting of the American Society of Mechanical Engineers.

United States and other trading nations of the world. The Bureau also reiterates its position with regard to the use and adoption of the metric system, and has passed resolutions, setting forth the simplicity of the system, the ease with which it is learned and remembered as contrasted with the system now in use in the United States, expresses its conviction that it would be a great advantage to the foreign trade of the United States if the system were adopted here, and strongly urges such adoption.

The Experience of the Pennsylvania Railroad with the De Glehn Compound Locomotive.

EDITORIAL CORRESPONDENCE.

The readers of the AMERICAN MACHINIST will remember that at the St Louis Exposition of 1904, the exhibit of the Pennsylvania Railroad included a De Glehn compound locomotive which had been imported from France in order that its performance might be compared with American engines. The engine has now done about 40,000 miles of service in the regular work of the road, and some very interesting facts have developed. After this amount of service the engine met with an accident which sent it to the shop, and advantage has been taken of the circumstances to completely dismantle it in order to examine the wear of the parts. To a mechanic's eye it is needless to say that in this condition it is a far more interesting object than in its running condition.

The most striking thing about it is the superior workmanship of many of the parts, and of these the most noteworthy are the driving wheels. These wheels are forged, but in their painted condition no one would suspect it. Few cast wheels are so perfect in outline; in fact, were the wheels of brass castings they could not be more true to pattern than they now are. Of course it is easy to hint that they are an exhibition job with extra care devoted to them, but this does not alter one's admiration for them. The wonder is how they were made at all and I hazard nothing in saying that such wheels simply could not be produced in this country.

The castings are almost equally noteworthy. All are superior, though the iron castings, while far superior to the general run of castings made in this country, show less difference than those of steel. Of these latter the most noteworthy is a brace piece between the frames, which is of complex form with many ribs and gussets. The truth of this casting to pattern can only be compared, like the driving wheels, with a brass casting, as it is far ahead of what would be expected in iron while, the material considered, it is simply of a degree of perfection which is not produced in American foundries.

Another feature is the smallness of the bearing surfaces and their surprisingly small amount of wear. The rear or bearing faces of the driving-wheel hubs are deliberately turned away until the bearing surface left is but about 1½ inches wide, against about 3½ inches in Pennsylvania practice. With this limited surface rapid wear would be expected but it is just what has not taken place. After 40,000 miles of service the tool marks are scarcely effaced, although experience would lead one to expect decided wear even with the much larger surfaces of Pennsylvania engines. The driving-box wedges again show no measurable wear. As regards the driving-wheel hub faces there is no apparent explanation of the results, but in the case of the wedges and some other parts it is apparently due to the remarkable hardness of the case-hardened surfaces. Other small surfaces are the driving box journals which measure 8x9½ against 9¼x12½ inches of the Pennsylvania engines, the low-pressure eccentrics which are of 1½ inches face against 3, and the crank-pins which, for the forward parallel rod bearing, are 3 15-16x3½ against 5⅜x4½ inches.

No doubt the favorable results with these bearings are largely due to the divided stresses resulting from the compound cylinders but, nevertheless, no American designer would be bold enough to use them.

Another marked difference from American practice lies in the diameter of the boiler tubes which are of 2 25-32 against 1⅞ inches, outside diameter as usual on Pennsylvania engines for similar service. The flues, too, have eight internal or Serve ribs ¼ inch high to assist in absorbing the heat from the gases and in transmitting it to the water.

Unfavorable as well as favorable experiences have resulted from the service use of the engine, the most notable being with the fire-box stay-bolts. After only a thousand miles of service these began to break in an alarming manner and eventually nearly one-half of them had to be renewed. These bolts are of copper, as are the internal fire-box sheets, and were replaced with bolts of phosphor bronze. A possible explanation of their failure lies in the narrow water legs, which are but 3¼ inches wide against 4½ of Pennsylvania practice, but this explanation is not satisfactory. Presumably these spaces represent ordinary French practice and the question, why do these bolts give satisfactory service in France and promptly fail here? seems to be unanswerable.

A remarkable illustration of what would here be looked upon as bad designing lies in the oil cellars of the driving boxes, which, in addition to being very small, are so arranged that in order to renew their supply of waste it is actually necessary to remove the wheels from the engine. On American engines this can be done without dismantling anything and in a very few minutes' time.

Another feature of this kind is the attachment of the various steam fittings of the cab to the boiler by gasket packing, where here metallic joints would be used here as a matter of course.

A lot of ten new engines is nearing completion at Juniata in which some of the features of the De Glehn engines have been incorporated. Of these the most noteworthy is the Walschaert valve gear. The French engine has this gear on all cylinders, that for the high-pressure cylinders being external and driven from return cranks while that for the low-pressure cylinders is internal and driven from eccentrics. The Pennsylvania engines are not compounded and hence the gear is external. It is curious to note that whereas the link motion has always been defended because it is between the frames and hence out of harm's way, the chief advantage of the Walschaert gear seems to be that it is without the frames and hence easily accessible. The piston valves have a diameter of 14 inches, with a throw of 6⅞ for the forward and 5⅝ inches for the backward motion. The lap is 1⅝ inches and the lead ¼ inch. This lead is of course constant, and it is noteworthy that it is made equal to the running gear lead of the Stevenson link and would seem to be excessive for the full gear or starting position.

F. A. H.

According to a local paper Johan Timko, a buffer in a Bridgeport factory, was killed almost instantly a few days ago by being pierced to the heart by a blade of a pair of shears. Timko was working at a buffing wheel, and in some manner lost his hold of the blade as the point was nearing the wheel. The blade was caught and shot directly toward him with such force that the sharp point penetrated through his clothing and pierced his heart.

Personal.

W. B. Scott, for many years foreman of the New Bedford Foundry & Machine Company, has resigned his position to accept a similar one at the Rodney Hunt Machine Company, Orange, Mass.

R. Wallace McKee, who has been Boston superintendent for Burdick & Son, became a member of that company January 1 and has been elected vice-president and general manager.

A. R. Lentz has resigned his position as superintendent of the Weatherby Foundry and Machine Company, and has accepted a similar position with the Williams Brothers Company, general founders, Philadelphia, Pa.

Arthur H. Jorns, formerly with the Pratt & Whitney Company, and for many years engaged in selling American machinery in Europe for Schuchardt & Schütte, has now associated himself with

the sales department of the Gardner Engineering Company, of New York.

W. B. Harsel has resigned his position with the Columbia Graphophone Company to take a position with the Gardner Engineering Company, of New York, as designing engineer. Mr. Harsel has in the past been connected with the Niles-Bement-Pond Company, and also with the Aluminum Plate and Press Company, of Plainfield, N. J.

Obituary.

William Tubbs, for years a manufacturer of iron work for trucks, died at Norwich, Conn., February 5, aged 72 years.

Per Brynn, head draftsman of the Carnegie Steel Company, died at the New York Hospital, February 10. Mr. Brynn, who was a Norwegian, was married at Pittsburg, February 1, and was on his wedding trip when taken ill.

Commander George W. Mentz, inspector of ordnance and acting captain of the League Island Navy Yard, died suddenly at Philadelphia on Sunday of apoplexy. He was known as one of the most distinguished ordnance officers in the navy and was assigned to the League Island station last July. He was appointed to the Naval Academy from Newark, N. J., in September, 1866.

Anderson Fowler, of 60 East Sixty-eighth street, New York City, died suddenly on board the steamship "Republic" in the harbor of Genoa, February 10, aged 63 years. He was president of the American Ventilating Company, vice-president of the Chapman Iron, Coal and Coke Company, and a director in the Alleghany Ore and Iron Company, the Empire Steel and Iron Company and the J. B. & J. M. Cornell Company.

In tearing the shingles off a roof, where they had been for twenty-odd years, it was found that the cut nails which had been used were practically as good as when first driven, being only slightly rusted, though the shingles were much decayed. On another portion of the same roof, where the shingles had been on less than half as long, the wire nails were almost entirely rusted away, while the shingles were still good. This would seem to indicate that there might be a market for cut nails yet, though doubtless galvanized wire will last even longer than they.—*The Wood-Worker.*

Nickel and cobalt molten and ⅛ per cent. magnesium added becomes malleable, ductile and can be highly polished, can be welded with steel and iron, and can be rolled into thin sheets without separation and polished.

The Swiss government has definitely decided that the operation of the Simplon tunnel shall be by electric traction. As is well-known, this, the longest of railroad tunnels (about twelve miles), is the last link of a line through the Alps connecting Switzerland with Italy. The Swiss government, after a study of the Valtellina (Italy) electrically operated railroad, has adopted the same system for the Simplon. It will be the three-phase alternating current system of Ganz & Co., the potential at the contact wires being 3000 volts. It is hoped to have the line open for traffic by next May.

From our Consul-General Guenther, of Frankfort-on-the-Main, comes the report of the discovery in Germany of a new metal known as tantalite, which is said to be extremely hard. Sheets made of this metal were shown to be so hard that a diamond drill which worked for three days and nights at 5000 r.p.m. produced a scarcely noticeable impression upon the metal, though the drill itself was dulled. It is stated that it is expected to make pens of this material, and that for that purpose it will have an elasticity superior to gold pens, that it will resist acids in a high degree and will be superior to any other metal for the purpose.

Business Items.

The Triumph Electric Company of Cincinnati, have appointed the Hallidie Machinery Company, Seattle, Wash. as their agents for the Northwest Pacific Coast.

The Boston Gear Works, 152 Purchase St., Boston, Mass., have about completed their new shops and are now equipping them. They would be pleased to receive catalogs of mechanical goods.

On March 1st Dodge & Day will remove to their new offices, located in the Drexel Building, 5th & Chestnut Sts., Philadelphia, in order to be nearer to the financial center as well as to obtain more commodious quarters.

About February 22nd., the Chicago office of the National Acme Manufacturing Co., Cleveland, O., will occupy quarters, warehouse facilities included, in the Edgcomb Building, at Clinton and West Washington Streets, with office at No 56 West Washington Street.

Manufacturers.

Niles & Scott, Laporte, Ind., wheel manufacturers, will enlarge their plant.

The new factory for the Taunton (Mass.) Crucible Company is being rapidly completed.

The American Ice Company, Brooklyn, N. Y., is planning to erect a $100,000 ice plant.

The American Radiator Company, Springfield, Ohio, is going to build an addition to its plant.

The C. M. Scott Packing Company of Baltimore, Md., will erect a canning factory in Dover, Del.

Plans are being drawn for Charles M. Clay, Jr., Poughkeepsie, N. Y., for a cold storage plant.

It is reported that the Bryant Electric Company, Bridgeport, Conn., will build another extension.

The Emmert Manufacturing Company, Waynesboro, Pa., makers of vises, will enlarge its plant.

The car barns and power house of the Canton-Akron Traction Company at Canal Dover, Ohio, were burned entailing a loss of about $100,000.

The spring bed factory of Himebaugh Bros., Jamestown, N. Y., was destroyed by fire. Loss $30,000.

The Frick Company, Waynesboro, Pa., is to erect a new boiler house to be equipped with the latest machinery.

The Dixie Manufacturing Company, Baltimore, Md., galvanized exhaust pipes, etc., will erect a new building.

The Illinois Warehouse Company, Peoria, Ill., will build a cold storage plant at a cost of $200,000 or more.

The Abbeville, S. C., shops and roundhouse of the Seaboard Air Line were destroyed by fire. Loss $100,000.

The Union Gas Engine Company, of San Francisco, Cal., will establish a branch factory in Oakland, Cal.

The Memphis (Tenn.) Fibre Plaster Company, a new concern, has secured permit for the erection of a plant.

The Lewis Corrugated Culvert Company has been incorporated at Elyria, Ohio, with George H. Lewis as president.

The Homan Manufacturing, making electroplated hollow ware, Cincinnati, Ohio, will put up a new $50,000 plant.

Plans have been accepted by the Blackmer Rotary Pump, Power and Manufacturing Company, Petoskey, Mich., for a new plant.

An addition for the manufacture of concrete fence posts is to be built to the plant of the Denning Fence Works, Cedar Rapids, Iowa.

The Golden Cycle Mining Company has decided to spend $400,000 in enlarging and improving the Telluride mill at Colorado City, Colo.

The Covert Manufacturing Company, general and saddlery hardware, Troy, N. Y., will build an addition to its factory and employ about 200 hands more.

The Wide Range Drill Chuck and Tool Company, has been incorporated at Muncie, Ind. Capital $50,000. W. E. Hitchcock, Charles Anthony and others, incorporators.

The Brooklyn (N. Y.) Rapid Transit Company, has filed plans for the erecting of a sub-station at Richmond Hill. There will be two transformers of about 4000 horse power.

The plant of the Max Ams Machine Company, Mt. Vernon, N. Y., was damaged by fire to an extent of nearly $10,000. Many cog wheels and much of the belting was destroyed.

The Chicago, Milwaukee & St. Paul Railway will spend about a quarter of a million dollars in improvements at its shops in Dubuque, Iowa. Among these will be a new machine shop.

The Pawnee Cereal Company has been incorporated at Cedar Rapids, Iowa, with a capital of $1,000,000, and will erect a $400,000 plant. Edward Ellsworth of Buffalo, N. Y., is president.

The Motor Components Company, recently organized in Des Moines, Iowa, and which has taken over the plant of the old company located at Milford, Conn., has closed contract for the erection of a plant at Des Moines.

The Walter Auto-Car Company is being formed with a capitalization of $1,000,000 to manufacture the auto-car now being made by the Walter Auto Company of New York. A large plant will be erected in Trenton, N. J.

Catalogue Notices.

American Well Works, Aurora, Ill. Bulletin No. 96 describing the "American" centrifugal pump. Illustrated, 6x9, pp. 24, paper.

Massachusetts Institute of Technology, Boston, Mass. Report of the President and Treasurer presented at the December, 1905, meeting of the corporation.

A. D. Granger Co., 95-97 Liberty St., New York. Bulletin describing the method of the installation of complete power plants by this company. Illustrated, 6x9, pp. 23, paper.

Diehl Manufacturing Co., Elizabethport, N. J. Catalog of electric fans for all currents except alternating, small motors for sewing machines. Illustrated, 6x9½, paper.

Jeffrey Manufacturing Co., Columbus, Ohio. Bulletin No. 11 which contains an article on "The Application of Electricity to Mining," by F. L. Sessions. Illustrated, 8x10, pp. 44, paper.

Fosdick Machine Tool Co., Cincinnati, O. 1906 catalog of radial drills, motor drives and horizontal boring, drilling and milling machine. Illustrated by half-tone engravings. 6x9, pp. 55, paper.

The Strong Machinery & Supply Co., 48 Franklin St., New York. Pamphlet entitled "The Engineers Monthly," giving information about the different kinds of packing made and handled by this company.

The Lodge & Shipley Machine Tool Co., Cincinnati, O. Catalog "R" describing various types of lathes. This is printed on fine coated paper and contains numerous half-tone illustratons, tables and line drawings. 6x9, pp. 98, paper.

The Emerson Electric Mfg. Co., St. Louis, Mo. Catalog No. 4200, describing Emerson fans for alternating current. Illustrated, 7x9, pp. 39, paper. Catalog No. 4220, of Trojan fans for alternating current. Illustrated, 5½x8, pp. 31, paper.

C. W. Hunt Co., W. New Brighton, S. I., N. Y. Pamphlet No. 061, which is an introduction to the general line of machinery made by this company, including elevators, steam shovels, steeple towers, etc. Illustrated, 3½x6, pp. 24, paper.

Whitlock Coil Pipe Co., Hartford, Conn. Booklet giving specifications of the different kinds of pipe and pipe bends made by this company. Illustrated, 3½x6, pp. 12, paper. Circular illustrating and describing the Whitlock atmospheric condenser.

The Norman W. Henley Publishing Co., 132 Nassau St., New York. "Catalog of Practical Books for Practical Men," including books relating to shop construction, machinery, steam engineering, automobiles, electricity, pattern making, etc.

The Henry & Wright Mfg. Co., 111-137 Sheldon St., Hartford, Conn. Catalog of ball bearing drill presses and filing machines, containing description and use of the idler system as applied to these drill presses. Illustrated, 6x9, pp. 20, paper.

The National Steam Pump Co., Upper Sandusky, Ohio. Catalog No. 27, of single and duplex pumps and air compressors. This also contains useful information for the engineer, including tables and other things, and copy will be sent on request to the company. Illustrated, 6x8½, pp. 100, paper.

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat free. E. G. Smith, Columbia, Pa.

Cox Computers, 75 Broad st., New York.

Development of Turbines. Kevorkian, Turbine Eng. 627 Rose Bldg., Cleveland, O.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Parallel attachments for drawing tables. F. G. Hobart, Beloit, Wis. Dealers or by mail.

Electrical apparatus designed and built. Geo. M. Mayer, 1131, Monadnock Block, Chicago, Ill.

Light and fine mach'y to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Work wanted for a Cleveland automatic lathe; handles 2 in. and under. The Earle Gear and Machine Co., 141 Oxford st., Philadelphia.

Andorn & Martin, consulting engineers, will develop your ideas, put your inventions into marketable shape. 25 West 15th St., New York City.

Work wanted—We are thoroughly equipped for building fine automatic machinery. The G. N. McKibbin Manufacturing Co., South Norwalk, Conn.

Any kind development work, special automatic machines, gas engines, automobiles, etc., designed. H. P. Moorees, M. E., E. E., 7 East 42nd St., New York City.

Wanted—To build special machinery, jigs, fixtures, punches, dies, power press tools and machine work. Accurate work guaranteed. Chas. S. Dexter, Attleboro, Mass.

Mechanical Draftsmen—3 first-class men on jigs, punches and dies, and fixtures, for large manufacturing company in Chicago. Engineering Agency, Monadnock Block, Chicago.

Mechanical Draftsmen, for a large manufacturing company in Illinois. Ten first-class men, experienced on gas engine work. Must have some practical shop experience. Box 185, AMERICAN MACHINIST.

Superintendent—For plant in New York State, producing heavy material on which close and accurate finish is required. Must be aggressive, and a good business man. Engineering Agency, Monadnock Block, Chicago.

Draftsmen—Experienced designers of jigs, dies, tools and fixtures for positions in New York, Ohio and Pennsylvania—$75 to $125—Applicants should send sample of work. Engineering Agency, Diamond Bank Bldg., Pittsburg, Pa.

Superintendent—For large plant in Wisconsin. Must be able to handle a large number of men, and have thorough experience on tool, gear and transmission work, and especially on steel drawing. Engineering Agency, Monadnock Block, Chicago.

Wanted—Native of Great Britain to act as Sales Agent and to devote his entire time to representing in Great Britain the United States makers of a steel specialty used in manufacturing plants. State salary expected and give full particulars as to age, experience, reference, etc. Box 181, AMERICAN MACHINIST.

Tool Catalog No. 22, 950 pages, bound in cloth. Greatest small tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton st., New York City.

For Sale.

For Sale—Patent No. 810,319 of improved V block. Box 169, AMERICAN MACHINIST.

For Sale—Two new electric traveling cranes. See advertisement page 87 this issue. Pawling & Harnischfeger, Milwaukee, Wis.

For sale—A Pedrick and Ayer pneumatic riveter for ⅝" rivets. 18" gap, 10" spread. Used one month. In perfect order. J. L. Lucas, Bridgeport, Conn.

For Sale—Gas engine business with engines from two to sixty horse power capacity. Stock of finished and unfinished engines and patterns, drawings, etc. Will sell at a bargain. Apply Box 55, AMERICAN MACHINIST.

Business Opportunities.

Partner wanted with capital to take active part in light manufacturing. Address Box 193, AMERICAN MACHINIST.

Wanted—Machine shops or capital, to take up manufacturing of cutters and reamers on a new, patented principle. Address Box 149, AMERICAN MACHINIST.

Solid manufacturing business must increase capital to fill orders. Party with $10,000 can secure interest. Profits large and sure. Only those of high standing need apply. Box 190, AMERICAN MACHINIST.

A young man (29) who has had a technical education and eight years experience selling Machine and Electrical tools wants to represent one or two manufacturers in New York City. Advertiser has many personal acquaintances among machine tool dealers and users and is at present representing one firm, whom he is privileged to offer as reference. Office is in center of machinery district, and would be conducted as New York office of parties represented, on either salary or commission basis. Box 166, AMER. MACH.

Wants.

Situation and Help Advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names of which their replies are not to be forwarded, but replies will not be returned. If not forwarded they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted.

Classification indicates present address of advertiser, nothing else.

ILLINOIS.

Superintendent wishes change. Age 39. Technical and practical, modern economical methods, of production, experienced designer. Adding machines and automatic machinery. Box 197, AMERICAN MACHINIST.

IOWA.

Situation wanted by a foundry foreman who would like to make a change. Strictly up to date in modern foundry practice. A-1 chemist and metallurgist. Good systematizer, and good reference. Box 189, AMER. MACH.

MASSACHUSETTS.

Designer on automatic machinery and tools for same. 18 years experience, technical and practical. Box 196, AMER. MACH.

Technical man would change. Eight years experience in shop engineering and manufacturing. Designer of automatic machinery, tools, fixtures, etc. At present in charge of drafting room; similar position preferred. Box 155, AMERICAN MACHINIST.

NEW JERSEY.

Superintendent—A man with ability to reduce shop cost and increase output. Address W., 251 Clinton Ave., Newark, N. J.

Master mechanic with 15 years experience in construction and repair work pumps, etc., in large factories. Box 179, AMER. MACH.

Mechanical Engineer, age 27, graduate Cornell desires to change. Experience on steam engines, compressed air machinery and boilers. Worked in shop, drafting room and on the road as salesman. Box 191, AMER. MACH.

Engineering designer seeks position; Corliss engines, pumping and blowing engines, gas engines, power stations. American, extensive experience, inventive, accurate, good habits; competent to take charge. Box 88, AMERICAN MACHINIST.

A practical mechanical man, age 37, 20 years experience on medium heavy automatic machinery working his way through machine shop and drawing room, superintendent for past 9 years desires position with substantial company. As Superintendent organized new shop of 300 men, purchased tools, installed cost keeping system and put plant in complete running order. Address Box 188, AMERICAN MACHINIST.

NEW YORK.

Chief Draftsman—Small and medium machinery engines, compressors, wishes to change. Box 170, AMERICAN MACHINIST.

General foreman, (36) successful in handling men and work to best advantage, varied experience in high-grade machinery, practical mechanic. Box 173, AMERICAN MACH.

Mechanical Engineer—Large experience with jigs and fixtures. Has letters from well known firms abroad and United States. Open to engagement as foreman. Box 198, AM. M.

I have successfully filled all positions from apprentice to superintendent of large concerns. Have good executive and mechanical abilities. Am inventive, energetic, sober and reliable. A-1 references. Box 202, AM. M.

Wanted—Position as works Superintendent. At present Assistant Superintendent with

large Corliss Engine Co. Familiar with modern methods. Machinist by trade. Member of the A. S. M. E. Box 203, AMERICAN MACHINIST.

A young man 21 years, has had two years school instructions and practice in mechanical drawing and can do neat work, desires position in the drafting room of an engineering, machine or construction company, as an assistant draftsman. Box 171, AMER. MACH.

PENNSYLVANIA.

General experienced die maker for sheet metal goods, etc., fine and complicated work. A-1 reference, wishes position in Philadelphia. Box 172, AMERICAN MACHINIST.

General foreman, 35, successful in handling men and work to best advantage; varied experience in high-grade machinery. Expert machinist. Box 161, AMERICAN MACHINIST.

Superintendent, Mechanical Engineer, long and thorough experience in the design, manufacture and selling of machine tools, hydraulic machinery. Power and hydraulic presses. Special and testing machinery, desires engagement. Box 168, AMER. MACH.

Help Wanted.

Classification indicates present address of advertiser, nothing else.

CANADA

Wanted—Experienced machinists on general repairing and new work. None but good workmen need apply. Address Frank Egan, Niagara Falls Machine & Foundry Co., Niagara Falls, Canada.

ILLINOIS.

Draftsman—We have positions now open for draftsmen. Call or address Western Electric Co., Chicago, Ill.

Wanted—Experienced outside erecting men on Automatic Bottle House Machinery. Good opportunities will be offered to experienced, reliable men. Give full particulars when answering. Box 180, AMERICAN MACHINIST.

Wanted—Foreman to take complete charge of a department manufacturing and assembling light, interchangeable parts, employing from 50 to 75 men. To a reliable ambitious young man steady work and good inducements will be made by a growing concern. Only those employed in similar positions need apply. State age, references and wages wanted. Correspondence strictly confidential. Box 183, AMERICAN MACHINIST.

Wanted—Chief Draftsman and engineer having experience and practical familiarity with elevating, conveying and power-transmitting machinery, to take charge of drafting room in large concern manufacturing the line of machinery specified. Must be able to manage the drafting room to secure rapid, effective and accurate work. Engineering ability and as well keen appreciation of the manufacturing and commercial necessities of the business are desirable. For a man of the required training and capacity a permanent position is open where his value to the concern should steadily increase. Address with as full particulars as possible. Box 174, AMERICAN MACHINIST.

INDIANA.

Wanted—One first-class wood pattern maker on automobile engine work. Address Box 182, AMERICAN MACHINIST.

Wanted—Foreman with experience in erecting four cylinder motors for automobile work. Good position in a well established Automobile Company for the right man. State experience, references, and salary wanted. Address Box 200, AMERICAN MACHINIST.

MASSACHUSETTS.

Wanted—Two good first class machinists or tool makers on light work. Pleasant shop and surroundings; factory twenty miles from Boston. State age and experiences. References will be required. Box 160, AMERICAN MACHINIST.

MICHIGAN.

Draftsman wanted by a Detroit firm on jigs and fixtures for manufacturing gasolene engines and automobile parts on the interchangeable plan. Permanent position for a competent person. State age, experience, wages, nationality and full particulars. Box 186, AMERICAN MACHINIST.

NEW JERSEY.

Wanted—A foreman pattern maker. Apply to Benjamin Atha & Company, Newark, New Jersey.

Wanted—A first-class mechanical draftsman; state experience and salary wanted. Box 881, AMERICAN MACHINIST.

Wanted—First-class lathe and vise men for small steel work. Steady work, good pay, no trouble. Twenty-five miles from New York City. Box 194, AMERICAN MACHINIST.

Wanted—Foundry Foreman to take charge of shop employing 70 men. One hour's ride from Philadelphia; must be a capable man, qualified to handle men and familiar with modern appliances. S. B. H., 192, AM. M.

We are increasing our tool-making department and solicit applications from toolmakers and machinists who are experienced on fine and complicated work. Apply to Victor Talking Machine Co., Camden, N. J.

Wanted by an established firm in the vicinity of New York a practical Electrical and Mechanical Engineer, able to make winding calculations on small D. C. motors and to take charge of the manufacturing. Exceptional inducement to the right man. State experience, age, nationality and salary expected. Address, Opportunity, Box 187, AMERICAN MACHINIST.

NEW YORK.

Mechanical draftsman wanted for good jobs in New York. Box 201, AMERICAN MACH.

Wanted—Draftsmen for jigs, fixtures, dies and shop tools. Apply to Mergenthaler Linotype Co., Brooklyn, N. Y.

Automatic Screw Machine Operators wanted immediately. Send references to Drawer 7, Syracuse, N. Y.

Wanted—First-class die-maker for work on dies for cabinet hardware. Permanent position for capable man. Box 195, AMER. MACH.

Wanted—Experienced man on tools and jigs for cheap production of steam valves. Give reference and experience. Box 162, AMERICAN MACHINIST.

Wanted—Draughtsmen on tools for small interchangeable work. Steady position to good men. Address American Machinist, Box 175, AMERICAN MACHINIST.

Toolmakers—Wanted immediately first-class toolmakers on high-grade dies, jigs, gauges and special fixtures for small machine manufacture. Send references to Drawer 7, Syracuse, N. Y.

Wanted—Assemblers familiar with clock and instrument work also drill press, lathe and bench hands, small work. Answer stating experience and wages wanted. Box 178, AMERICAN MACHINIST.

Wanted—A first class mechanical draftsman with several years experience in constructing rock drills. State age, whether married, nationality, experience in detail and wages wanted. Box 158, AMERICAN MACH.

Wanted—Assistant Superintendent for large manufacturing works, located in the East, engaged in the manufacture of high grade, light interchangeable work. Must be a good mechanic with broad experience in handling men and capable of directing fixture and small tool design. Address X. Y. Z., 204, AMERICAN MACHINIST.

A first-class all-around mechanic, for blanking and automatic wire forming machine tools, with considerable executive ability in making all kinds of dies, a man capable of bringing tools and machinery up to the highest possible point of efficiency. A first class and steady position to the right man who is willing to come to Plainfield, N. J. Address giving age, experience in full, stating positions held in past, references and salary desired. P. Mfg. Co., 184, AMER. MACH.

The Works of the Russell, Burdsall & Ward Bolt & Nut Co., are located at Port Chester, N. Y., a delightful residential town 26 miles from New York on the shores of Long Island Sound. They have places open for a number of first-class all-around machinists. Their business is rapidly increasing, they are constantly adding to their equipment and require additional force to build new machines and take care of existing equipment. Steady work is assured for intelligent, capable and reliable men. References and qualifications required.

OHIO.

Draftsmen Wanted—Two or three first-class draftsmen, familiar with heavy engine design. Apply or address The William Tod Co., Youngstown, Ohio.

Wanted—Foreman to take charge of 20 men making jigs and small tools. One who has had similar position. Address The Cincinnati Milling Machine Co., Cincinnati, O.

A company employing about 250 men and building a line of machine tools wishes an assistant superintendent. The position requires a practical mechanic of executive ability and who has a faculty for handling men. Give references, state experience and name salary desired. Box 167, AMER. MACH.

Wanted—First-class man to take charge of designing of up to date jigs and fixtures for machine tool work. Must be capable of giving instructions in use of same. None but parties having practical shop experience need apply. State experience and salary wanted. Address Cincinnati Milling Machine Co., Cincinnati, O.

PENNSYLVANIA.

Wanted—High-grade erecting machinists for air compressor work—The Blaisdell Machinery Co., Bradford, Pa.

Wanted—Assistant draughtsman, to assist in designing laundry machinery; Wilson Laundry Machinery Co., Columbia, Pa.

Wanted—Young man who has had experience as Purchasing Agent, or Assistant; one preferred who has had mechanical or machinery experience. Address, Box 176, AM. M.

Wanted—Mechanical Engineer. One who has had some experience or who has graduated recently, as Mechanical Engineer, to take charge of testing and general shop work, for machinery manufacturing plant. Address Box 177, AMERICAN MACHINIST.

Wanted—A foreman capable of taking charge of machine shop equipped principally with light and heavy turret lathes, adapted for pneumatic tool work. Must understand design of turret tools, jigs, etc., and rapid duplication of parts. Box 199, AMER. MACH.

The Monotype Company maintains a school to train young men to meet the constantly increasing demand for operators of its type casting and composing machine. These operators have done so well that it receives more applications for places than can be filled. In making selections these qualifications carry most weight; common sense, type foundry experience, printing office experience, automatic machinery experience. Full particulars will be furnished to inquirers who furnish the same information about themselves. The Lanston Monotype Machine Co., 1231 Callowhill St., Philadelphia, Pa.

RHODE ISLAND.

Wanted—First-class draftsmen on special tools, jig and fixture work for light high-grade machinery. Apply to The Taft-Peirce Mfg. Co., Woonsocket, R. I.

Toolmakers Wanted—First-class workmen on jig and fixture work for light high-grade machinery. Permanent employment to competent workmen. Apply to the Taft-Peirce Mfg. Co., Woonsocket, R. I.

WISCONSIN.

Wanted—To meet with our constantly increasing requirements, we invite applications from first-class machinists, moulders and pattern makers. Giddings & Lewis Mfg. Co., Fond du Lac, Wisconsin.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen, with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AM. M.

WEST OF MISSISSIPPI.

Wanted—A good, practical, up-to-date wood machinery workman, in an agricultural manufactory in a large Western City, one who is qualified for foreman. Address, stating age, experience and salary expected. Box 164, AMERICAN MACHINIST.

Wanted—Graduate mechanical engineer, with shop and drawing room experience, to take position in our draughting room, to learn our business, with view of representing us as sales agent in large city. Curtis & Co. Mfg. Co., St. Louis, Mo.

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